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CONTENTS, PAGE 86
ADV'G INDEX, " XVIII.

MACHINERY:

VOL. 3. No 3. PUBLICATION OFFICE: 411-418 PEARL STREET, NEW YORK CITY. NOVEMBER: 1896.

A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY:

The simplest Drop made

This Drop Hammer contains one improvement that alone will commend it to all manufacturers. In the new Head or Lifter which we have recently constructed, and are now putting on the market, we dispense with the eccentrics in common use, and for them substitute a solid, wrought steel eccentric shaft, which is placed at the back of the Head instead of the front, and connected to the side rod by a long lever forging. This steel eccentric shaft has a fixed bearing at each end, which obviates the binding in the movable roll shaft, a difficulty that is often experienced with the usual form of eccentrics, after the pin has become worn. This style of Head, after eighteen months use in a number of shops, has proved its merit by giving entire satisfaction to all purchasers. Made in eight weights of Hammers: 150 to 1 800 lbs. The height and width between uprights can be varied to suit buyers.

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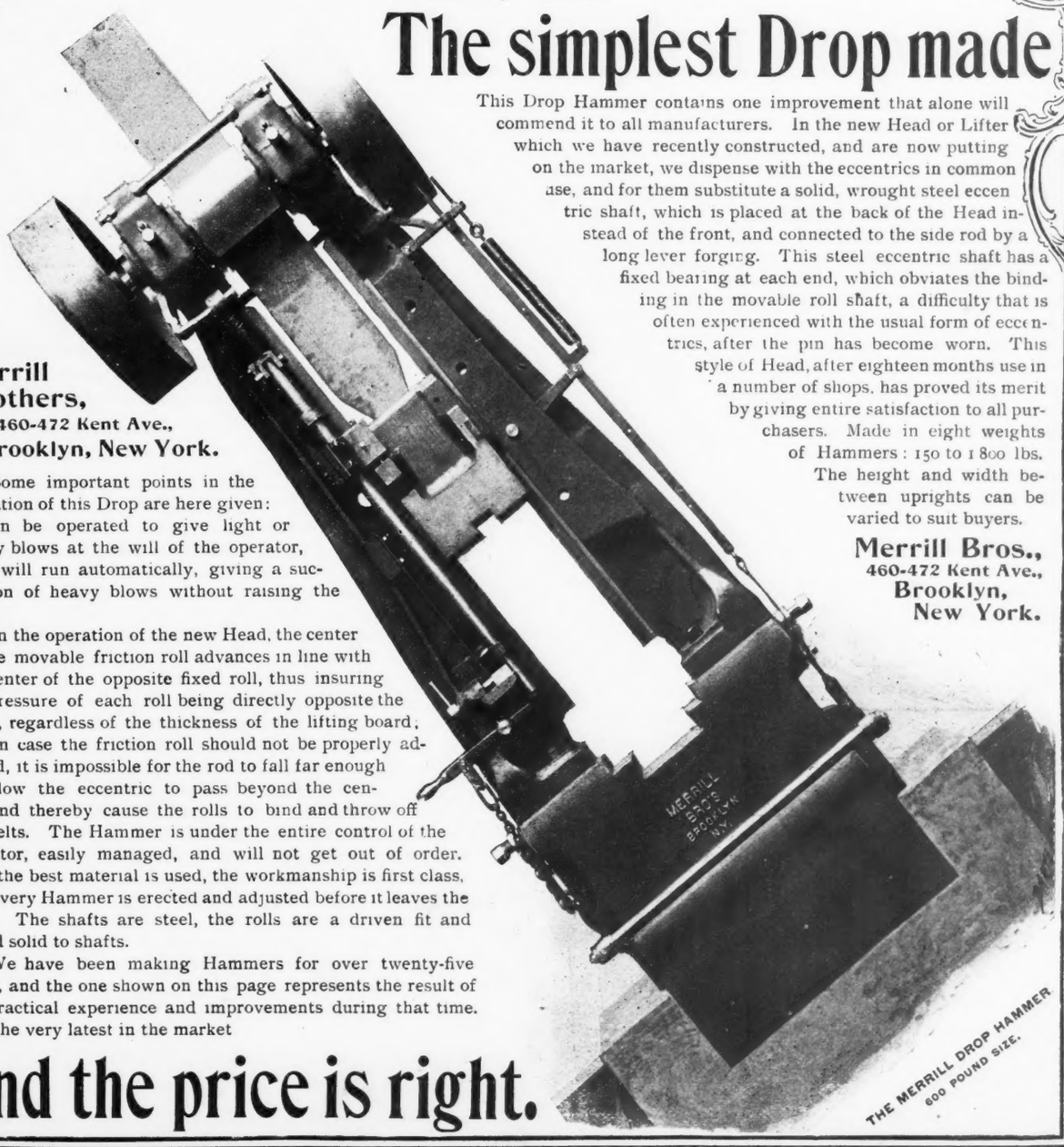

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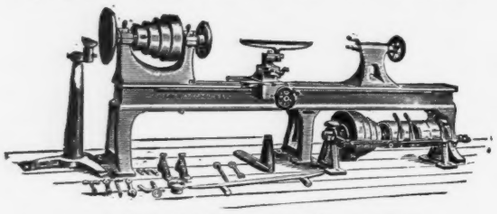

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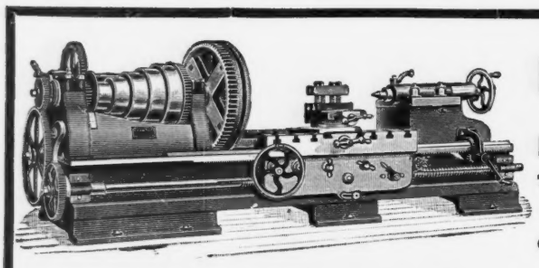

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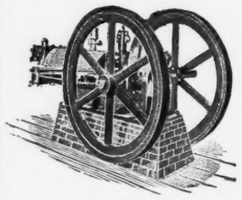

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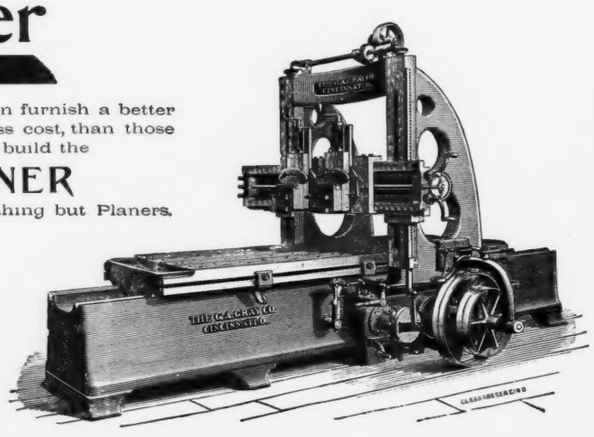


MACHINERY.

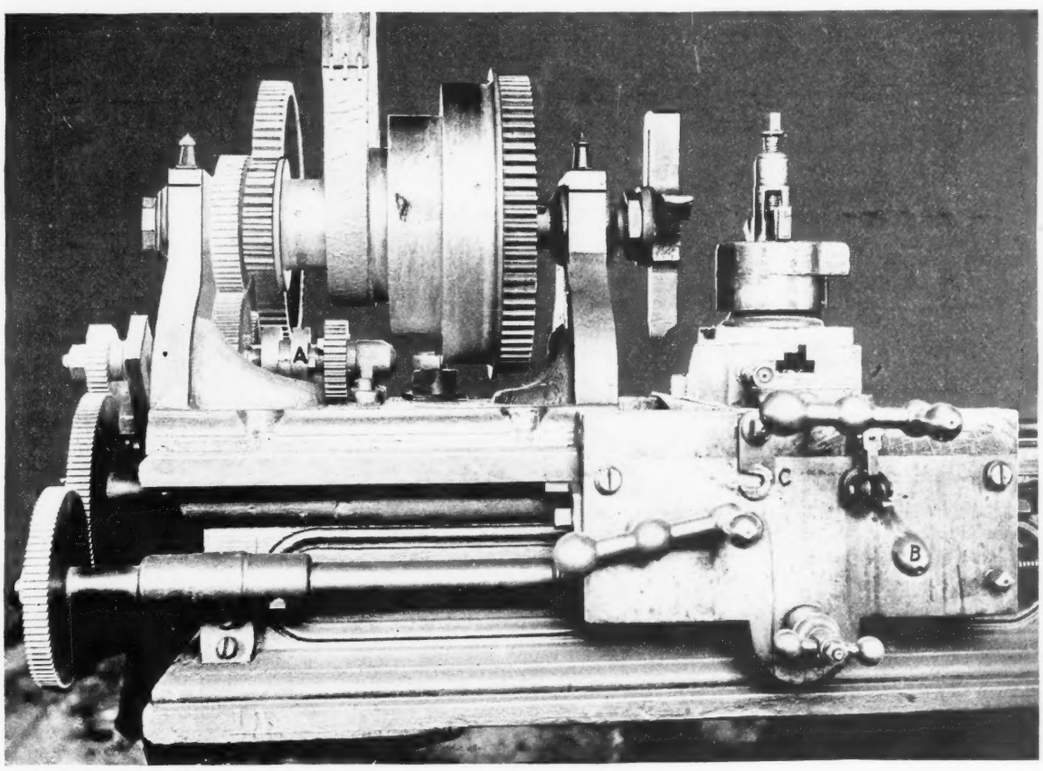
VOL. 3. November, 1896. No. 3

THE OLD AND THE NEW.*

AS there is so much said relating to the new features of engine lathes and their carriages, it is interesting to note the lathe shown, which was built about 1860 by Gage, Warner & Whitney, of Nashua, N. H. The carriage was quite convenient, although it did not have some of the latest devices, but the largely advertised feature of being able to throw out or reverse the feed without leaving the carriage, is here in all its glory.

The handle B was connected by rod and bell crank to the spool A, which carries projecting lugs on each side to engage in the gears each side when thrown into either position, or disengaged as shown. The connection between handle B and rod which actuates A is of course a sliding one, allowing the clutch to be worked from any position on the bed.

This was a feature in the lathes of this company, who had a reputation for ingenuity and good work, as can be seen in this as well as other tools which will be shown later.



OLD LATHE WITH FEED REVERSE IN CARRIAGE.

The strap C swings up to act as a stop for the feed screw of tool block, as is sometimes done to-day.

* * *

THE FIRST BRITISH MAN-OF-WAR.

JOHN T. USHER.

In view of the interest which has of late years been centered in the construction and maintenance of the war ships in the navies of the world, it cannot fail to be interesting at this time to take a retrospective view of the subject and see from what a crude beginning the present magnificent examples of naval architecture have sprung.

The engraving* (page 72) is said to be a correct representation of the "Henry Grace De Dieu," more commonly known as the "Great Harry," built by Henry VIII. in 1514, at an expense of £14,000 ($70,000). This ship was, properly speaking, the first British man-of-war. It was of 1 000 tons burthen, was manned by 349 soldiers, 301 marines and 50 gunners; carried 19 brass and 103 iron pieces of ordnance. She had four masts, and port-holes on both decks and in other places. Before the period of her construction the ordnance pieces of a war vessel were always placed above deck, but a French shipbuilder of Brest, Descharges by name, having about that time invented "port-holes," this ship was the first vessel to adopt them.

The name of the "† Henry Grace De Dieu" (Great Harry), is supposed to have been changed in the reign of Edward VI to "The Edward," which, on the 26th of August, 1552, was reported to be still "in good case to serve," and ordered "to be grounded and caulked once a year, to keep it tight." No subsequent notice of this ship is to be met with in the British naval annals, but it is supposed to have been burned at Woolwich, August 27, 1553, about one year after the above mentioned notice and in the first year of Queen Anne.

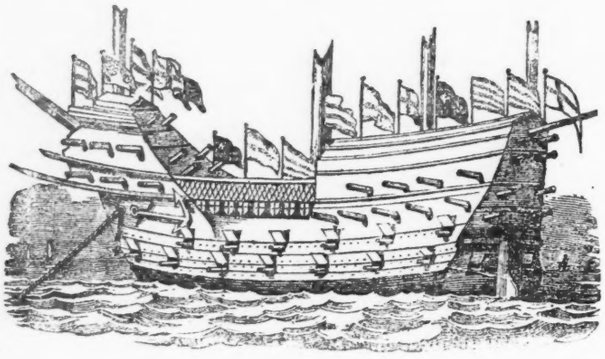
Henry the Eighth, who from his long residence on the Continent (at Bretagne, France) had opportunities of acquiring greater skill in maritime affairs than most of his predecessors, seems to have been the first British king who thought of raising and maintaining a naval force such as should be at all times sufficient for the preservation and service of the state. It was he, also, who founded the dock-yards of Deptford, Woolwich and Portsmouth, and also the Trinity House.

The above account of the "Great Harry" is taken from "The Mechanic's Magazine," London, October 25, 1823, and "The Wonders of Nature and Art," London, 1839. Elsewhere, however (unless I am mistaken) I think I have read of the "Great Harry" being propelled in a "calm" and at "close quarters in action" by means of "oars" in the hands of "galley slaves," of which a

* From the library collection of Mr. Pepys, at one time private secretary to Charles II. and James II. of England, and a man famed for his learning and his knowledge of state, naval and civil affairs.

† Literally, "Henry Grace of God."

number were usually carried on the vessel for this purpose, the lower rows of "guns" being withdrawn and the "oars" projected through the "port-holes." On this point, however, I am not positive, as many authentic records of such things and events



THE FIRST BRITISH MAN OF WAR "THE GREAT HARRY."

which have been preserved in my family (some dating back three hundred years) are in England, and are not at this time accessible to me.

* * *

BOILER HORSE POWER—ISOMETRIC DRAWING.

"THERMAL."

It ill becomes a tyro in steam engineering to attempt to criticise so good an authority as W. H. Wakeman, but as I fail to see the logic in his arguments for "Boiler Horse Power," I shall try to give my reasons for differing from him.

"Raising 33,000 pounds one foot high in 1 minute of time, or its equivalent, constitutes a horse power in an engine.

The evaporation of 30 pounds of water per hour from feed water at 100° Fah. into steam at 70 pounds pressure constitutes a horse power in a boiler. Is there any good reason why we should accept one and reject the other?"

The reason why we should discriminate between these two units is simply this. The horse power is the unit of dynamic effect, wherever that effect is measured, either in an engine or other agent for the transmission or utilization of mechanical energy. In order that there shall be no confusion, it is essential that there shall be but one unit for this purpose and that it shall always have the same value. It is true that the horse power was originally intended as a basis of measurement for work done by the steam engine, but after a use of many years, its adaptability to the measurement of power under any and all conditions is recognized and it stands to-day the universally accepted standard of power where the pound, foot and minute are the accepted units of weight, space and time.

The unit of evaporation that is quoted is of much later origin. It has by no means been as as universally accepted as the foot-pound-minute unit. Under these circumsances, it is right that we accept the unit that is sanctioned by the older usage.

In any event, we should accept one or the other, but not both. Mr. Wakeman has very clearly shown how to obtain the equivalent evaporation when the conditions of temperature and pressure vary from those specified in the terms of the unit. There is also an equivalence between heat units and foot pounds. If we calculate this we find that the Boiler Horse Power mentioned, is far in excess of the true Horse Power. If it is necescary that we have a unit by which to rate the boiler for commercial purposes, let us call it by some othername. The term Horse Power will mean but one thing and there will be no question whether we mean a Boiler Horse Power or an Engine Horse Power.

But do we need such a unit, and in view of the varying conditions under which boilers are used, is it possible to have a unit that shall be really satisfactory for the purposes of comparison? Is it not better, for commercial purposes that the engine and boiler be considered as one machine, from which a stated effective Horse Power shall be economically delivered.

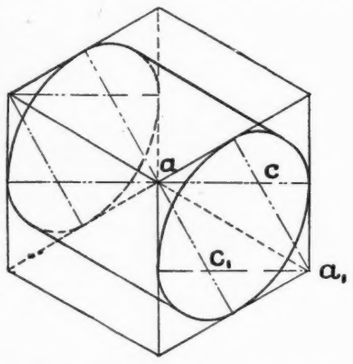
The unit that is proposed, requires a certain amount of calculation that is really productive of no good results. If the would be purchaser attemps to make these calculations, and specify the power of the boiler with which he is to be supplied, he simply shoulders the responsibility of the matter himself, and, if in his ignorance of the subject, he neglects to take into consideration some of the many factors that enter into the problem, he has no redress whatever.

In purchasing a boiler, the best method is to discard the use of the term Horse Power, as commonly used in connection with the boiler. Specify the conditions under which the boiler is to work, and then demand a guarantee that the boiler shall fulfill the conditions named. By this method only, is satisfaction guaranteed, and then only when the work of planning and supervising the erection of the plant is in the hands of a competent and experienced man.

If then, the Boiler Horse Power is of no real service in the purchase of a boiler, under what conditions is it useful? It cannot serve any good purpose in an engine, as, adding to the complications already involved, it does not add one iota to the value of the test. There is no new information gained after we measured the value of the boilers by this new unit. Why not simply compare boilers by the amount of water evaporated under standard conditions, without establishing a new unit which has no real significance and no intrinsic value. We certainly ought not to appropriate the name of a universally accepted standard and apply it to another unit whose usefulness is questionable.

It is not in a captious spirit that I would criticise another point in the paper. The terms Degree and Heat Unit are never susceptible of such an interchange as is made therein. It is never proper under any circumstances, to speak of "Degrees of Heat" in a quantitative manner. The term Temperature is comparable to the term Head in hydraulics. The Degree measures the tendency of heat to flow from one body to another, just as the Head of a fluid measures its tendency to flow from a higher to a lower level. The Heat Unit measures the amount of heat contained in a body and is independent of the temperature of the same, except when the weight or volume of the body are, taken into consideration. But even when these are taken into consideration, the degree cannot be made to measure the amount of heat, any more than we can measure the volume of a fluid by its depth.

I was greatly interested in Junior's resume' of the various methods of dimensioning drawings, in use at different shops. I am strongly opposed to scaling drawings of any kind. Blue prints shrink so much that close scaling is difficult. I have seen a large print that had shrunk nearly an $\frac{1}{8}$" per ft. and that I consider to be too much for even a pattern maker to work to. Moreover, it oftens happens that the drawing is to be re-duplicated on some other sheet or sheets. The consequence is that in every case the drawing must be scaled. This loss of time would be saved if the dimensions were recorded as soon as determined.



I enclose you a sketch of a method for drawing a cylinder in isometric projection that is, to me, preferable to that shown by Mr. Rouillion.

Draw the rhombus, or "Isometric" square that would circumscribe the end of the cylinder, and from the points (a) and (a_1) draw lines to the middle of the opposite sides. The points (a) and (a_1) and the points of intersection (c) and (c_1) are centers, from which arcs can be struck that will combine to form approximate ellipse.

This construction, which I learned when first studying drawing, is much quicker than that of using off-sets, and also dispenses with the use of the irregular curve. The use of the "curve" should, I believe, be resorted to as little as possible. The straight line and the circular arc are, in most cases, fully adaptable to all practical needs, as well as to the most artistic ideals of the practical designer of machinery.

* * *

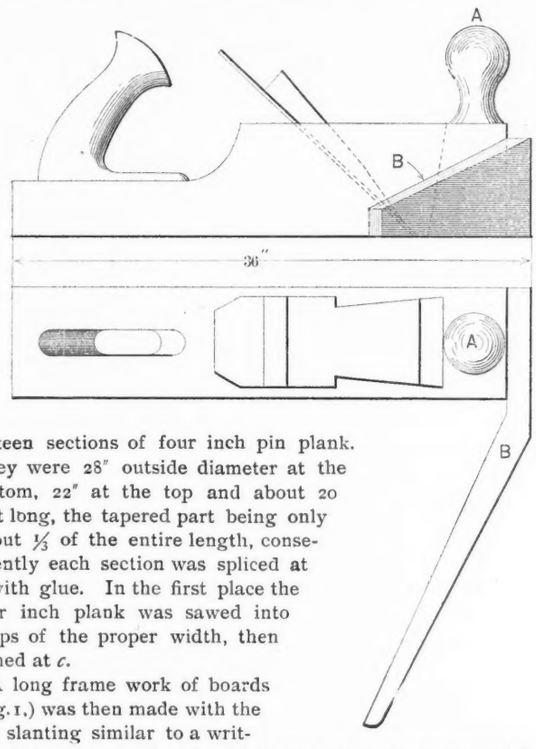
It's a good plan to keep track of your work. Then you'll know whether or not you are "taking a good deal more time on this job than on the last," if your foreman tells you so.

* We are indebted for these figures to Prof. J. E. Denton's paper on the "Performance of the Twin-Screw Steamer City of Lowell," read before the Society of Naval Architects and Marine Engineers in New York in November, 1895.

FROM ACTUAL PRACTICE.

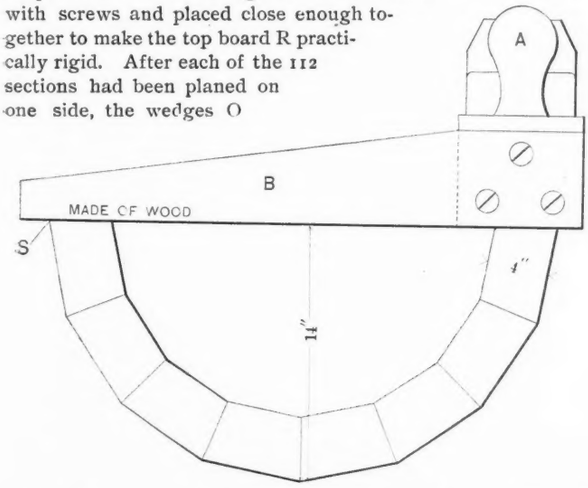
MILO.

Among some of the unusual tools noticed lately, I wish to mention a few that were made by one of the workmen in a woodworking establishment visited recently, one of which was a plane three feet long with four inch blade called the "man killer" by his shopmates. It was made like any ordinary wooden plane except that it was larger and had a guide B, and a knob A, near the front end. He was making seven large hollow pillars for a summer mansion, the circumference of each being glued up in



sixteen sections of four inch pin plank. They were 28" outside diameter at the bottom, 22" at the top and about 20 feet long, the tapered part being only about ⅓ of the entire length, consequently each section was spliced at *c* with glue. In the first place the four inch plank was sawed into strips of the proper width, then joined at *c*.

A long frame work of boards (Fig. 1,) was then made with the top slanting similar to a writing desk at an angle of 11¼ degrees from the horizontal base, so that when one of the square sections of a pillar W was placed upon it and the whole thing run through the planer, the corner L was planed off at the proper angle to fit against the next section to form one of the sixteen joints in the circumference of a pillar. The strips M and N acted as stops for holding the work in place sidewise while in the planer, which made each piece of uniform shape and size. The wedges O were fastened with screws and placed close enough together to make the top board R practically rigid. After each of the 112 sections had been planed on one side, the wedges O



were taken out and replaced by others with just twice the amount of taper so that the slanting top of the fixture was at an angle of 22½ degrees to the base instead of 11¼. The strip M was changed to the other end as shown in Fig. 2 and each section was planed on the other side as before, bringing it down to the proper size and shape to form one of the sixteen sections in the circumference of a pillar. It will be noticed that as each section crooks at C, the end F lays over onto a higher part of the slanting surface than the rest which of course will make that part tapering and thinner from F to G than it is from G to H, which is necessary on account of its being at the smaller end of the pillar. The amount of bend at C and the slanting surface of the fixture being just enough to give it the desired shape and size when finished. In gluing the sec-

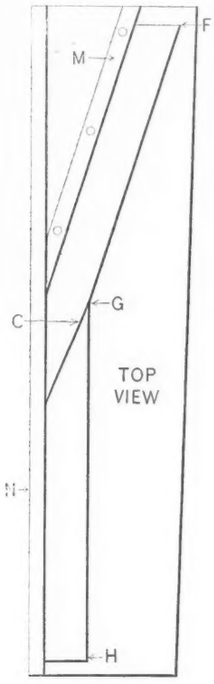


Fig. 1

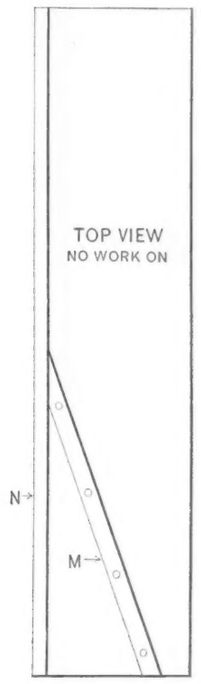
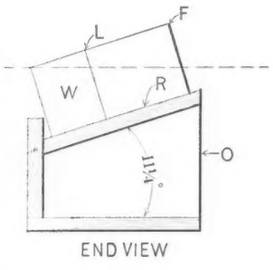
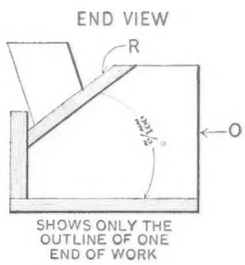
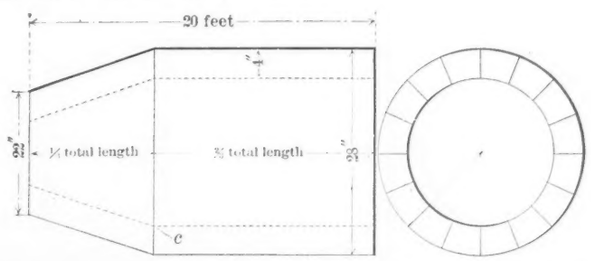


Fig. 2





tions together the ends were held by ordinary clamping staples and the hand clamps applied, each pillar being made up in halves then the halves glued together. In jointing the halves together, the "man killer" was used, the guide B extending across to the opposite side of the work at S, prevented the plane from rocking and made it about as easy to obtain a joint straight across from

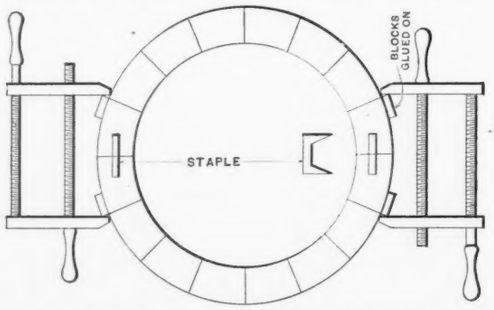


side to side as if the plane had been wide enough to cut on both surfaces at the same time.

The plane was not so much of a man killer as might be supposed. One man could walk along and push it, taking a uniform shaving from end to end; but to make the work easier, a second man took hold of the knob A and walked along in front to help pull it. In gluing the parts together, a bearing for the hand clamps was obtained by gluing on small blocks which were easily removed

before turning the pillars, which was done in a temporary lathe constructed especially for it.

In regard to the cost of such special tools, I might add this



plane cost about one day's time in addition to the stock, the blade being made from a piece of Jessop's steel $\frac{3}{8} \times 4'' \times 6''$ which cost less than 60 cents. It paid for itself several times over on the one job.

* * *

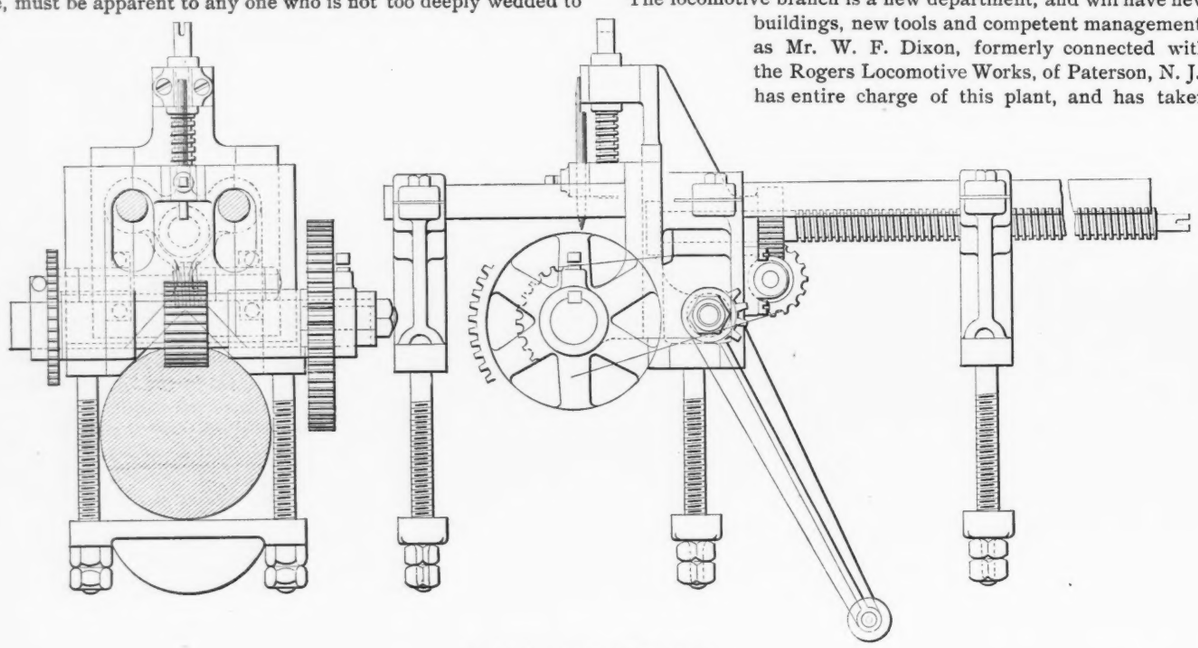
We are informed by Mr. Geo. I. Rockwood, M. E., who has just returned from a visit to England and France, that in the latter country it is the custom to use very high pressure steam in the electric lighting plants. The boilers carry about 225 pounds per square inch, which is reduced at the engines according to the load, so as to maintain an economical cut-off at all times. With a light load the pressure is reduced; when the heavy load comes on in the evening the initial pressure at the engine is increased, and approximately the same cut-off is maintained. The plan evidently has much to commend it.

Mr. Rockwood also remarked that in all Paris one could hardly find a steam exhaust, and that a view from a high building failed to reveal any clouds of steam such as we see in any large city in this country, where they vary from the little "piff-puff" of the three cat power engine to the heavy exhaust that make umbrellas a necessity on the street below. The secret of the difference is the extensive use of compressed air, which has been developed to a wonderful extent. It is reheated before using in the motors, and its general adoption certainly indicates its economy, which should encourage the advocates of compressed air in this country.

* * *

THE BURR PORTABLE KEYSEATER.

The value of a keyseater which, weighing but 50 pounds, can be carried to any part of the shop, or to any other shop if need be, must be apparent to any one who is not too deeply wedded to the idea that a hammer and cold chisel are good enough. And there are probably those who think they can chip a keyseat faster than any hand machine can mill it. It will, however, take a pretty lively chipper to cut a $\frac{5}{16} \times \frac{5}{8}$ inch keyseat at the rate of 12 inches an hour, which can be easily done by a laborer, with one of these machines.



BURR PORTABLE KEY-SEATER.

The engravings, which are made from working drawings of the machine, show its mechanism quite clearly; the end view at the left, showing a shaft in position, and the cutter at about the bottom of the keyseat.

The machine consists principally of a head, which contains the driving gear and cutter, and two rods which are fastened to the head and carry the clamps used to hold the shaft while being milled. The power is applied through the pinion and gear, whose teeth are only shown in part, the milling cutter being on this shaft, and turning once to three revolutions of crank.

The feed is given by a chain working over the sprockets shown and working a worm gear on the screw shown, which feeds the cutter, into the work, and will feed 12 inches at one setting.

Each machine is furnished with a set of cutters, which enable keyseats to be cut from $\frac{1}{4}$ to $1\frac{1}{8}$ inches in width inclusive, varying by sixteenths. A gauge, showing depth of keyseat, is provided. Cutters can be rapidly centered on shaft without the use of spacing collars. All gears are cut from the solid. It will cut keyseats in the shafting up to 5 inches in diameter. The complete machine weighs about 50 pounds, and is sold at a very reasonable price. It is built by John T. Burr & Son, Kent avenue and South Sixth street, Brooklyn, N. Y.

* * *

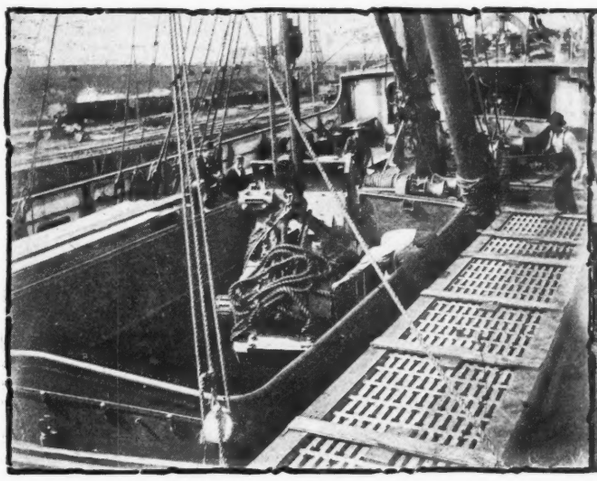
THE NEW RUSSIAN LOCOMOTIVE WORKS.

Some idea of the amount of work and money involved in starting a large locomotive works can perhaps be gained by a study of the accompanying photographs and description of some of the tools which are expected to arrive at St. Petersburg by the time this paper reaches its readers. The works are known as the Sormovo Co., a Russian-American concern which is about to engage in locomotive building at Nijni Novgorod, the main interior city of Russia, which contains 70,000 inhabitants and is on the Volga River, about 700 miles east of St. Petersburg. This is not an entirely new plant, a portion of it being engaged in shipbuilding for the trade of the Volga and Caspian Sea. It is interesting to to note that, as the Caspian Sea has no navigable or or even visible outlet, their work must be confined to these waters, but as if to even up matters, it also effectually prevents competition from builders elsewhere, as it would be impossible to deliver the vessels except in sections or by balloon transportion. This latter method is not yet in working order, although the redoubtable Pennington and his motor promised it several years ago.

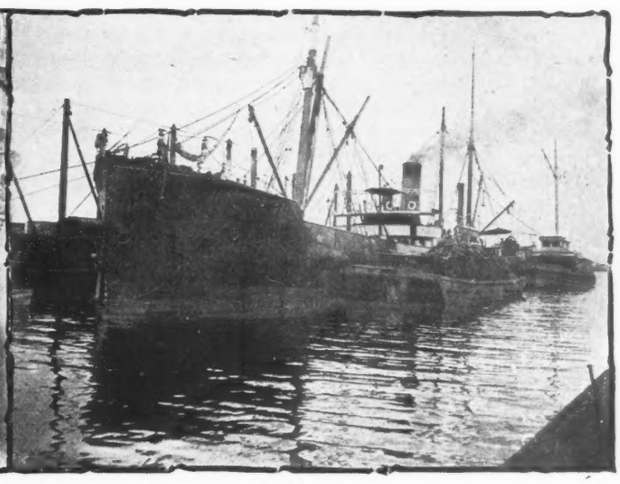
The locomotive branch is a new department, and will have new buildings, new tools and competent management, as Mr. W. F. Dixon, formerly connected with the Rogers Locomotive Works, of Paterson, N. J., has entire charge of this plant, and has taken several competent assistants from this country, among them being Mr. Frank M. Stevens and his son Henry M. Stevens (who took these photographs), both experienced in their line, having left the Baldwin Locomotive Works to accept these positions.

The right hand view of the first group shows the vessel itself, the Laleham, a "tramp" steamer which was chartered for this work. The barge alongside carries cord wood, which is used to pack between the different pieces of machinery to keep them from shifting. This also shows the large triple-head slotter, which is for slotting the three jaws of a locomotive frame at one setting.

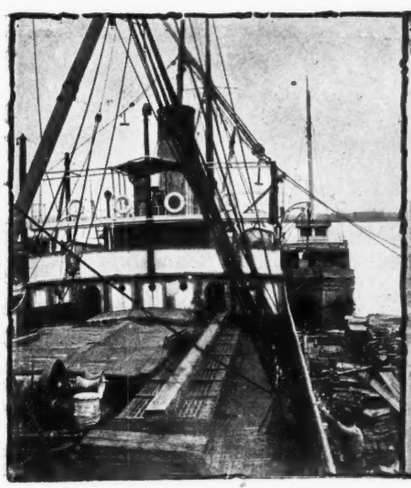
The central view of the next group shows a hydraulic boiler riveter, having a gap of 11 feet, and handling 1¼ inch rivets, with a pressure of 200 000 pounds on the dies, the water pressure being 1 500 pounds per square inch. By comparing the height of the men and the machine, a good idea of its massive proportions can be obtained. It weighs in the neighborhood of 23 000 pounds and was built by William Sellers & Co., of Philadelphia.



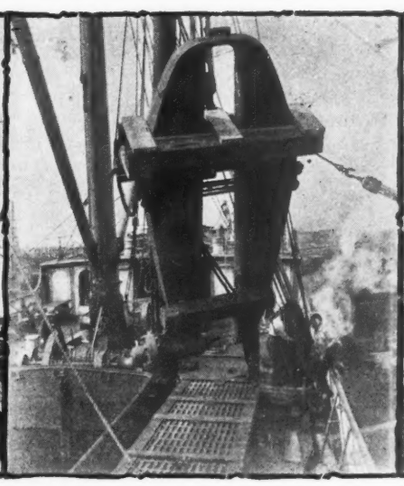
LOWERING INTO THE HOLD.



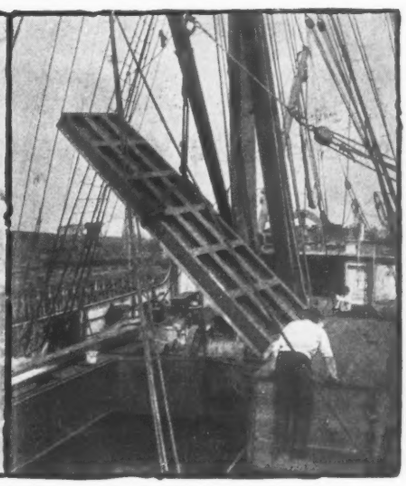
THE "LALEHAM" AND BARGES.



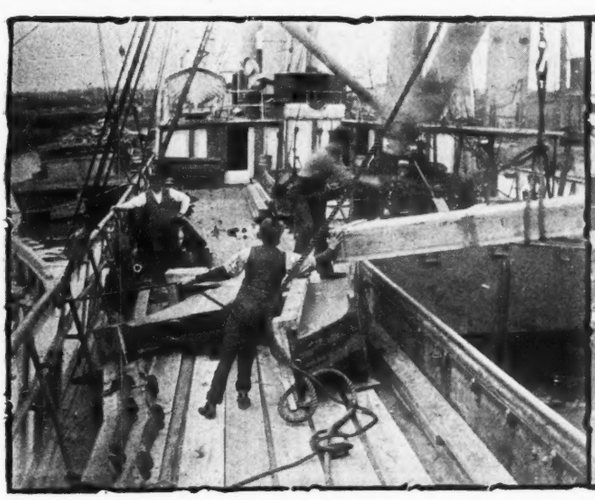
BED OF FRAME OF SLOTTER ON DECK.



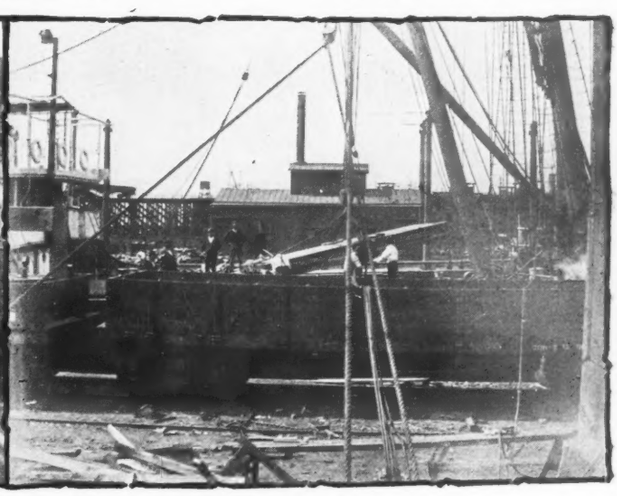
A LARGE BOILER RIVETER.



ANOTHER SLOTTER BED.



"EASY, NOW!"



"HOIST AWAY."

LOADING TOOLS FOR THE NEW RUSSIAN LOCOMOTIVE WORKS.

The slotter measures 38 feet by 44 inches, and can take in a frame 30 feet long. The bed piece shown weighs nearly 24 000 pounds.

On the opposite side of the hatchway is the bed of another large slotter, this one being double-headed instead of triple, and is five feet shorter, although it weighs nearly as much. These were too large to go below and were lashed to the deck, as shown.

In views 4 and 5 are shown some heavy boiler-making machinery, made by the Hilles & Jones Co., of Wilmington, Del. One of these is a boiler plate planer, which planes two edges of the plate at once, and at the desired angle with each other.

The vessel itself is 350 feet long, 33 feet beam by 35 feet deep,

and draws 21 feet of water when loaded with her full cargo of 3 000 tons. She was built in 1880 for the trade between England and China, but is in good condition, being entirely of iron and steel. Her crew contains 22 men all told, Captain Brown, three mates, four engineers, the balance being stokers, sailors and stewards, the latter being in demand after the first few days of internal dissensions are over.

The value of the machinery contained in her cargo is placed at nearly $500 000, aside from the five small locomotives for use in the yards of the locomotive works, and quite a quantity of pig iron, which was taken to prevent the shifting of the cargo.

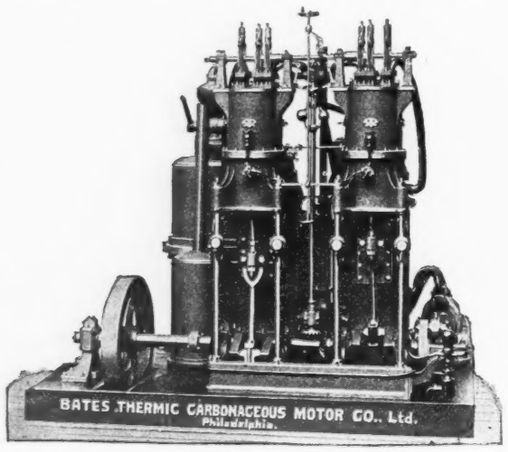
Besides the firms named, the cargo includes tools from Bement, Miles & Co., Philadelphia; Jones & Lamson Co., Springfield, Vt.; Prentice Bros., Worcester, Mass ; Brown & Sharpe Mfg. Co., Providence, R. I.; Pond Machine Tool Co., Plainfield, N. J.; Pawtucket Mfg. Co., Pawtucket, R. I.; Betts Machine Co., Wilmington, Del.; Newton Machine Tool Co., Philadelphia; Niles Tool Works, Hamilton, Ohio; Baldwin Locomotive Works, and Rhiele Testing Machine Co., of Philadelphia.

* * *

A NEW THERMIC ENGINE.

Another aspirant for thermic honors has appeared, and the highly desirable production of power direct from coal, without the use of the steam boiler and its attendant losses, is said to have been accomplished. It is the invention of a Frenchman named Gardie, who, after years of experimenting, patented a motor embodying these principles, but whose name seems to have been abandoned in the changes made since then, the name of Gardie being used only as applied to the gas used, which may or may not be a compliment.

This is a heat engine in which gas and air are used, but not as in the ordinary gas engine, for, instead of the mixture being exploded, the gas is burned in the cylinder and the air expanded by



NEW THERMIC ENGINE.

the heat thus produced, this driving the piston, which is of course single acting. This burning takes place in the upper part of the cylinder, and there is said to be a layer of air between this and the piston proper, making the lubrication of the piston an easy matter, as it is always comparatively cool.

The arrangement of the plant is as follows: A charge of pea size anthracite coal (about 28 pounds) is placed in the top of the "gascogen," or gas producer. Compressed air is forced into this and is mixed with a small jet of steam, the mixture passing up through the incandescent fuel, where it joins the products of combustion and forms Gardie gas, which is said to be a fixed gas, free from the usual by-products such as ammonia, tar, etc. The gas passes to a dust arrester, which is equivalent to a steam separator, throwing down any minute coal dust which might be in the gas, much as a separator throws down the water from steam. There are two single acting vertical cylinders 15.748 inches in diameter and with the same stroke (15.748 inches) connected to the crank shaft at 180 degrees, and which has a third crank at the end for driving the air compressor, which supplies the air to the gascogen and the cylinders. The gas now passes to a throttle valve, from which two pipes (one for gas, the other for air) lead to each cylinder, where they enter their respective valves, whose areas are so proportioned as to admit just the right quantity of each.

The piston has a plate of nickel which is first heated by electricity and is afterwards kept hot by the burning gases. On the admission of gas into the cylinder, it is ignited by the hot plate in piston and the mixture of air and gas, already under a pressure of 73.5 pounds per square inch, is expanded and then cut off the same as steam, giving a sharp cut-off. The exhaust goes to a regenerator, which is not unlike a surface condenser, containing small tubes which carry the compressed air to the cylinders, and gives up its heat to the air, it being claimed that nearly all the heat is thus expended in useful work. The upper part of cylinder can be likened to steam boiler, in which the burning of the gas inside the cylinder affords the heat, the water being in the jacket, which is divided into zones, so as to cause the water to circulate from top to bottom, or from cooler to hotter portions of the cylinder. The steam so made is used in the production of the gas in the gascogen.

This saving as well the heating of the air in the regenerators, show ingenuity and a right idea of economizing heat or energy. The utililizing of the water in the cylinder jacket is in direct contrast with ordinary gas engine practice, which wastes the heat, thus absorbed, and is to be commended. The engine is quite compact, the entire plant of 100 horse power occupying less than a 16 foot cube. Among its disadvantages are the necessity for an auxiliary steam boiler in starting up after a long shut down, an 8 HP. boiler being needed for a 100 HP. plant, also the necessity of electric heating of the nickel firing plates in the piston, although these are said to be necessary only after a shut down of several hours. Another disadvantage is the excessive noise, which may or may not be a necessary part of the system, but the engine now in operation is without exception the noisiest engine or motor the writer has seen.

The reports of the engine, by Thomas Pray, Jr., are interesting in some ways, and abound in italics and heavy faced type, which in some instances call attention to rather peculiar claims. Some of the advertisements in the dailies claim a saving of 80 per cent. in fuel over the steam engine, but as the report only figures out, after making all possible allowances, a consumption of .78319 pounds of coal per horse power per hour, this hardly seems to be borne out, for in making comparisons we must take the best in use as the standard to compare with. The engine is used to drive an Edison dynamo and Sturtevant blower, the brake test not being considered advisable by Mr. Pray. In this connection there is a rather amusing rumor current to the effect that the blower was used instead of the brake, to perform the double duty of absorbing and keeping the engine room cool enough to work in, but this is not an insurmountable obstacle, even if true. The engine is well built, and the inventor has taken the right course in endeavoring to eliminate the boiler from the power plant and utilize all the wastes possible, but as advances seldom come in 80 per cent. leaps, we must be pardoned for not crediting such a marvellous efficiency. The company is composed of several well known men, Mr. A. E. Kennelly being vice president and Prof. E. J. Houston a director. Further information concerning the marvellous efficiency of this motor can be obtained from the Bates Thermic Engine Co., 652 Bourse, Philadelphia, Pa.

* * *

A NEW RIVAL OF COAL AS FUEL FOR WARSHIPS

The French papers give particulars of experiments carried on by M. Paul d'Humy, a French naval engineer, which have had for their object the converting of petroleum and other oils into a hard, homogeneous mass, suitable for fuel on board warships and other seagoing vessels. The material he produces is not affected by either heat or cold, and is absolutely smokeless and odorless, and he believes it will in time completely change the present methods of propulsion of warships. He has been able to turn the highly inflammable oils into hard cakes of any size or shape, and says they can be stored anywhere without the slightest danger. When ignited, these cakes only burn on the surface, and give off an intense heat. The substance cannot evaporate, or cause an explosion. It requires very little draught to burn brightly, and makes no more than from 2 to 3 per cent. of ashes. He calculates that one ton of this fuel will equal thirty tons of coal, and that the cost will not be more than from £1 to £2 per ton.—*Foreign Exchange.*

NOTES FROM A ROVING CONTRIBUTOR.—3.

"ELASTICITY A MODE OF GRINDING"—A MITRAILLEUSE GRINDING MACHINE—A SAW-MAKER'S EXPERIMENT—GRINDING ENGINEERS—T-SQUARES AND THREE CORNER FILES—SHEFFIELD—J. MORTON POOLE.

My last notes were not sent to the Professor. The Editor, who himself understands grindstones, did not think it necessary. Well enough, too, because I am not done with this abrasive matter, and would have been choked off, so to speak.

One thing more concerning grinding and abrasive cutting I cannot explain, is the function of elasticity in the matter. Something must yield. That is certain. Perhaps we may say there must be a limit to pressure, which is possibly the same thing. I once saw a stone that weighed two tons mounted on a shaft five inches diameter, and hung upon the frame with screws. Beneath this an iron table, four inches thick, six feet long and two feet wide, to hold flat pieces to be ground, sixty of them at a time, ground to gauge, positively.

The stone was started, turned off true, saturated, and a table full of the pieces started through under the stone. Had Dr. Gatling been a spectator, then it would be a fair inference that he gathered the idea of his shower guns from that experiment. The pieces came out red hot, curled up like shavings, some of them, and impinged against a brick wall that fortunately lay in the plane of rotation. The attendant ran away at the first shot; so did the rest, and the table went on through, but cleaned off completely. Was it given up? No. An old grinder who was there said, "Put a soft board under these pieces and they will go through all right." The stone was raised 1¼ inches and a pine board of that thickness put under the forms. That machine is running now and has been for twenty years, and this suggests another yarn of like chronology and result.

A saw-maker out in Ohio wandered into a planing mill one day and saw some thin strips passing through a moulding machine. "There is the idea," said he; "I want a machine like that to grind my billet webs" (vulgar, buck saws).

He had the machine made; it was a fine looking one, certainly. Two 42-inch stones, one below and one above, with feed roller guides, *et al*, as the lawyers say. It was started and a saw put through, or started through, rather, because it came back the same way it went in—blue, hot and "pulled." "Change the belts," said the saw-maker. This was done, so the stones ran with the feed. The next saw went out the other way, blue, hot and "pulled." One stone was changed back to the other motion, so they ran oppositely. Then the stones "stuck," the belt came off and the experiment ended for the first course.

Some time after, the saw-maker hearing of the pine board experiment above related, the machine was started and a strip of pine wood half an inch thick was placed between two saws that were run through, reversed and passed through again. No further trouble. The Editor will expect that all this shall be explained. He is referred to the Professor.

The grinding men, engineers we should say, of this country, are here, a Mr. Blake, of Cohoes, New York; Mr. Baker, manager of the great Disston Saw Works at Philadelphia, and most notable of all in accurate grinding, J. Morton Poole, of Wilmington, Delaware. Mr. Blake went to England and formed a works at Newton Heath, near Manchester. Mr. Baker became manager of the Enterprise Manufacturing Co., at Philadelphia, and J. Morton Poole died many years ago.

Mr. Blake's labors and inventions were in "gauge grinding," that is, grinding to gauges or positive dimensions. He employed chain or linked tables passing the stones, moved by profile guides, and he succeeded in grinding a great many odd things at a rapid rate. Among these, carpenters' steel squares and triangular files. His principal achievements were made more than thirty years ago, and what their story, evolution and survival cannot be written here. Mr. Baker's inventions live yet, many of them; so do Mr. Poole's, but in neither case has commensurate honor and credit been given for labors in an almost unknown but important branch of processes, those of positive or shape grinding.

The fact is that except in Poole's inventions, both hot and cold treatment made such advances in speed and accuracy that no one would live in water-soaked garments and risk their carcass in the plane of a grindstone moving 30 feet a second. An old time hand grinder sat up over the top of the stone, on a saddle bar that was used to press the work down on the face. A light skylight overhead was desirable, so the grinder could go out that way on a section of the stone in case it burst, or "come away," as our nautical friends would say; a precaution that indicated some regard for a man that at any rate must be killed by the inhalation of metal fibres that destroyed his lungs in a few years at most.

The very essence of hand grinding is found around Sheffield, England, but a visitor cannot see much of it there. The grinders on cutlery, gun barrels and so on are hid away in back streets, up alleys, in basements and under dwellings, where no stranger can find his way, even if he had a plan to search over; and when he has to hang on to something most of the time to keep from tumbling down a hill into the river, the difficulty is increased. Then again there is no concentration of the industries. Our people imagine that some famed maker of cutlery at Sheffield has a huge building with numerous stones, and is amazed to find the headquarters in a little shop, or "store," as we would say, perched somewhere along Hill street. The factory is most likely a block or row of little dwelling houses, and three-fourths the work is sent out to home workers.

I intended in this section to say something of Poole's inventions in grinding, but as my space is measured off like the treacle at Dotheboy's Hall, there is no room to tackle this subject here. In belongs in "occult" mechanics, and I will append a tail relating to grinding on the "down side" of a stone. Nine out of ten men go to the front or approach the side of a stone to grind, get themselves slopped all over, mash a finger perhaps, or gouge a stone, with no other reason than that less pressure is required. "Takes the wire off the edge," some will say, which is nonsense, for a metal cutting tool, or one for wood either, because in the latter case the final edge is made after grinding.

No regular "grinder" goes to the front of a stone. He soon learns better than that and never thinks of such a thing. We get into ruts and go on sometimes for generations doing foolish and inexpedient things, blundering along. We don't know much, anyhow. I mean the "other fellow" don't.

* * *

PATTERN FOR A CONNECTING PIECE BETWEEN TWO DIFFERENT SHAPED PIPES.

GEO. GUNTZ.

As will be seen by the drawing, the lower pipe is shaped like Fig. 2, and the upper one is round. Fig. 1 is a side view; Fig. 2 a horizontal section of the lower pipe; Fig. 3 a top view of both pipes in exact relation to each other; Fig. 4 a set or triangles, as are also Figs. 5 and 6, and Fig, 7 is the pattern of half the connecting piece.

It will be noticed that the method employed is different from the other, and is known as triangulation; while the other is known as parallel intersection. In this method, in order to determine the length of any line running up the side of the piece, with the exception of the two outside lines, as *m*, *l*, and 5, 6*e*, it is necessary to construct a triangle whose vertical is the vertical height of the piece, and whose base is the distance which the upper end of the line overhangs the lower end; and this base can be found only by making a top view of all the parts in proper relation to each other, as shown in Fig. 3.

So it will be seen that to develop the pattern, if the vertical height of the piece is known, the side elevation in Fig. 1, is not necessary. It is given here only to give a clear idea of the piece required, and to show how the surface is divided into triangles, and how the points are obtained so that they may be correctly connected with the lines forming the triangles.

Now to lay out the surface as shown in Fig. 1, describe a half circle on the joint, as *l*, *g*, 6*e*. Divide one quarter into an equal number of spaces, and do likewise with the other quarter; then by vertical lines parallel to each other, drop these points down onto the joint line *l*, 6*e*. At the lower end of the piece lay off half of the section of the lower pipe, as shown. Divide the quarter circle into a similar number of spaces as you did one quarter of the upper section. Project the points to the joint line *m*, 5, and connect with solid lines and diagonally with dotted lines.

It will then be seen that that quarter of the surface is made up of triangles whose short sides are the distances between the points 6*a*, 6*b*, 6*c*, 6*d* and 6*e*, and 1, 2, 3, 4, 5; and whose long sides are the hypothenuses of triangles made up of the vertical

height of the pipe, and the distance which the upper end of the line overhangs the lower end. The other quarter is made into triangles by using the point *m* on the lower end, and the points 6*a* or *g*, *h*, *i*, *k*, *l*. These triangles have more or less of a curved surface; but there are yet two triangles whose surface is flat, as 1, 6*a*, *m*, on the side, and *m*, *l*, *n*, on the back (for location of point *n*, see Fig. 3).

Having gone this far in making the construction drawing, it will then be discovered that all the lines with the exception of the two above mentioned, are in perspective, and the only way to get their exact length is to either revolve the piece so that any line in succession will be the outside line, or to make triangles of which they are hypothenuses; and as the latter is the easier method, it is the one we use. To begin with, make a top view, as Fig. 3. Space off the two quarters of the circle in the lower section, as you did in Fig. 1, and connect with lines as shown; but it is better to space off opposite quarters of the circle, as shown, so that the lines on the back quarter will not cross those on the front quarter. This is to prevent confusion as much as possible.

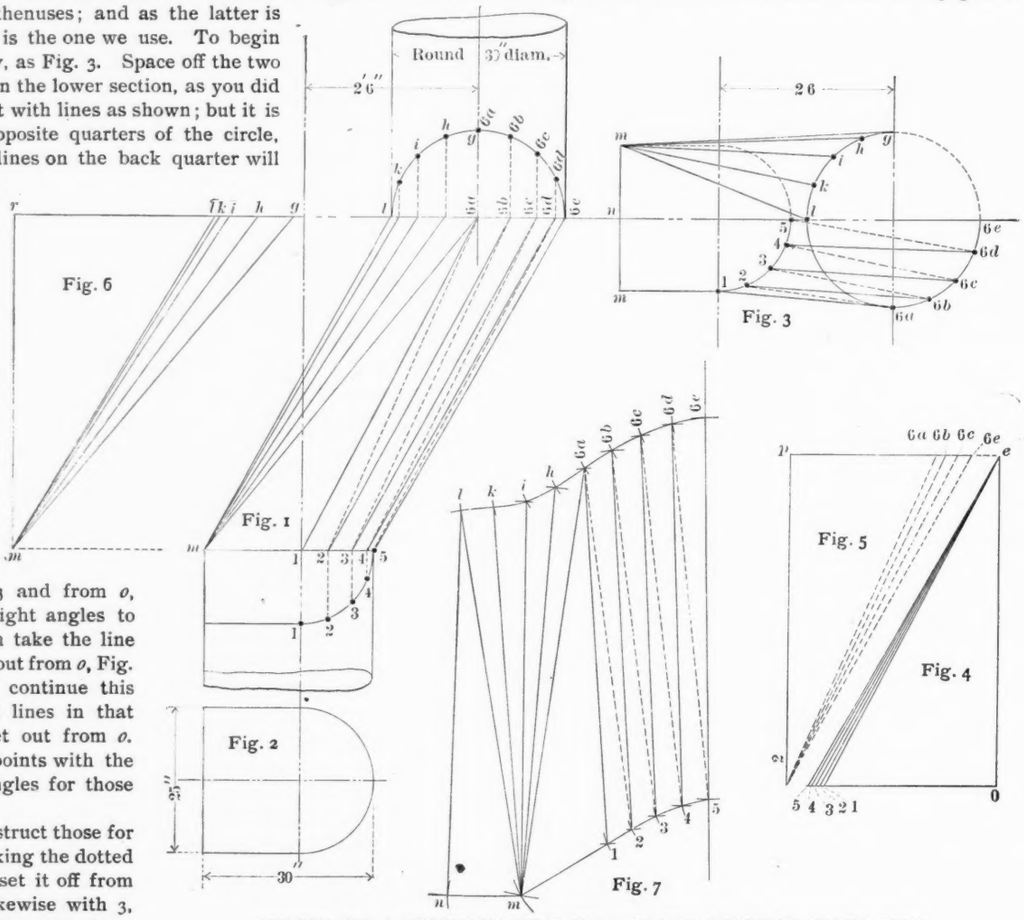
Having laid the top view out as shown, we are now ready to construct the triangles, which we will proceed to do as follows: Draw vertical lines, as *o*, *e*, Fig. 4; 2, *p*, Fig. 5, and *m*, *r*, Fig. 6. Then commencing to build the triangles in Fig. 4, take line 1, 6*a*, Fig. 3 and from *o*, Fig. 4, set it out at right angles to *o e*, make it *o*1. Then take the line 2, 6*b*, Fig. 3, and set it out from *o*, Fig. 4, making it *o*2, and continue this until all the five solid lines in that quarter have been set out from *o*. Then connect these points with the point *e*, and the triangles for those lines are completed.

Then proceed to construct those for the dotted lines by taking the dotted line 2, 6*a*, Fig. 3, and set it off from *p* to 6*a*, Fig. 5, and likewise with 3, 6*b*, 4, 6*c*, and 5, 6*d*. Connect these points with 2, and the triangles for the dotted lines are complete. For those on the back, take *m*, *g*, Fig. 3, and set it off from *r* to *g*, Fig. 6, then *m h*, to *r b*, *m i* to *r i*, *m k* to *r k*, and *n l* to *r l*. This completes all the triangles, and we are now ready to lay out the pattern.

Draw a vertical line, as 5, 6*e*, Fig. 7, and upon this set off the hypothenuse 5*e*, Fig. 4. Then take the space, 6*e*, 6*d*, from the upper circle, Fig. 3, and from 6*e*, Fig, 7, describe an arc 6*d*. Also take the space 5, 4, from the lower circle, Fig. 3, and from the point 5, Fig. 7, describe an arc 4. Then take the hypothenuse 2, 6*e*, Fig. 5, and from the point 5, Fig. 7, cut the arc 6*d*. Then take the hypothenuse 4*e*, Fig. 4, and from the intersection of the two arcs at 6*d*, cut the arc 4. Connect these points with the lines, thus completing two triangular sections of the pattern. Continue to annex triangle to triangle, until the line 1, 6*a*, has been drawn. This completes the front quarter of the pattern.

Now to annex the back quarter, take the distances 1*m*, Fig. 3, and from the point 1, Fig. 7, describe an arc *m*; then take the hypothenuse *m g*. Fig. 6, and from the point 6*a*, Fig. 7, cut the arc *m*, and connect the points by lines. It will then be seen that we have now the part of the pattern from 6*e* to 6*a* on the upper end, and from 5 to *m* on the lower end. Now we will go around the upper back quarter by taking the distance *g h*, Fig. 3, and from the point 6*a*, Fig. 7, describing the arc *h*. Then take the hypothenuse *m h*, Fig. 6, and from *m*, Fig. 7, cutting *h*.

Then take the space *h i* on circle, Fig. 3, with *h*, Fig. 7, as a center, describe the arc *i*. Continue this process with *m i* and *i k*, and *m k* and *k l* and *m l*. Then take the space *m n*, Fig. 3, and with *m*, Fig. 7, as a center, describe the arc *n*; then take the line *ml*, Fig. 1, and with *l*, Fig. 7, as a center, cut the arc *n*, and connect these points' lines, allowing laps for riveting at the top and bottom, and on the side *n l*, and half the pattern of the piece is complete. If it is desired to make the piece with two seams, laps must be allowed outside of 5, 6*e*, or the joints may be made on the side, on the line 1, 6*a*, instead of on the back and front.



PATTERN FOR A CONNECTING PIECE BETWEEN TWO DIFFFRENT SHAPED PIPES.

* * *

WIND.

FRED E. ROGERS.

Some time ago an item went the round of the newspapers to the effect that a California genius had designed a bicycle capable of carrying nine riders. This nonaplet, as it is called, has the ratio of gearing so high that the sanguine inventor claimed it possible to make the tremendous speed of one hundred miles per hour. Due allowance must be made for reporters' exaggeration, but it will not be without interest to consider for a moment what amount of energy would be required to maintain this speed in calm weather after the one hundred miles per hour velocity was acquired. Allowing nothing for friction in the machine or rolling resistance to the tires, the wind pressure would require the following amount of foot-pounds of energy to be expended.

At a velocity of 1 mile per hour the wind pressure or atmospheric resistance is .00492 pounds per square foot; at 10 miles per hour it is .492 pounds, and at 100 miles per hour it becomes 49.2 pounds, increasing as the square of the velocity. Taking the amount of surface exposed by the riders as that of the machine, and the first man in approved scorching fashion, three square feet would be a low estimate. $49.2 \times 3 = 147.6$ pounds, or 147.6 foot-pounds for every foot of progress. A velocity of one hundred miles per hour means 8 800 feet per minute: $147.6 \times 8\,800 = 1\,268\,800$ foot pounds. $1\,298\,880 \div 33\,000 = 39\frac{1}{3}$ HP., or an average of over $4\frac{1}{3}$ HP. for each rider.

Zimmermann, in some of his tremendous bursts of speed, is credited with exerting one horse power. If every rider of the nonaplet were a Zim it would require their best efforts to maintain, to say nothing of acquiring, the speed of fifty miles per hour.

LABOR'S VALUE—3.

W. S. ROGERS.

After experimenting in many ways with time cards for premium work, I have found the one given below the best for covering nearly every kind of work and at the same time reducing the clerical work to a minimum. The size is three and one-half inches wide by seven inches long, numbered consecutively, printed in duplicate and bound in padded form of not less than forty in a pad. The top one should be a light blue or drab in color for use in the shop and the duplicate underneath should be pink or white. A carbon should be used between them in making out tickets, and after the ticket used in the shop has been returned to the office with all work filled out on it and properly approved, the duplicate should be made to correspond. Then the duplicates should be separated and all of those covering the manufacture of each particular lot of machines, bound in book form and filed for reference by the cost clerk, to be used in the fixing of "limits" in building the next lot, and for notifying foremen of exceeded limits and getting the reasons for delays. The originals may be bound in book form, putting each workman's slips together that comparisons may be made to determine the most valuable men.

The "consecutive number" on this type of card is for the purpose of keeping it while in the shop and to allow the workman to check against error when receiving his pay.

(Face of card.)

AMERICAN LAUNDRY MACHINE CO.

TIME, WAGES AND COST CARD.

Department.....

3 S. O.....

Employee..... No.....

Work.....

Pieces.....

Symbol.....

Time.	Hours.	Dates.		
Began.....				
Ended.....				
		Rates.	Wages.	
		Cts.	$	Cts.
Limit.....				
Actual.....				
Premium.....				
Employee's earnings.....				
Cost per piece.....				

Correct: ..... Foreman.

Approved: ..... Sup't.

Read instructions and keep correct time on back of this ticket.

(Back of card.)

EXPLANATION.

The person accepting this ticket agrees to complete the work specified to the satisfaction of the foreman.

No allowance can be made for bad material or defective workmanship in any previous part of the work, unless the same is pointed out to the foreman as soon as discovered, and endorsed by the foreman.

Each workman must know, before commencing a piece of work, that it will finish to the size required, whether the work is to be completed by him or others.

The damage for spoiled work will be charged to the workman unless occurring from a reasonable cause and at once made known to the foreman.

All work to be inspected in progress, and to be approved before putting together.

This ticket must be carefully preserved and returned with the foreman's signature, and exact time kept, or no credit will be made.

W. S. ROGERS,
Superintendent.

TIME WORKED,			
Date.	Hours.	Date.	Hours.

AMERICAN LAUNDRY MACHINERY CO.

TIME, WAGES AND COST CARD.

Department, Machine.
98 S. O., 1,230
Employee, Haffley. No. 48
Work, turning, finishing.
Pieces, 5.
Symbol, 20 inch Amer. extractor baskets.

Time.	Hours.	Dates.		
Began	6.45 A. M.	5-1-96		
Ended	3.45 P. M.	5-1-96		
		Rates.	Wages.	
		Cts.	$	Cts.
Limit	10			
Actual	8	17½	1	40
Premium	2	6		12
Employe's earnings			1	52
Cost per piece				20½

Correct: T. ANSLEY, Foreman.

Approved: W. S. ROGERS, Superintendent.

Read instructions and keep correct time on back of this ticket.

AMERICAN LAUNDRY MACHINE CO.

TIME, WAGES AND COST CARD.

Department, Machine.
197 S. O., 1,235.
Employee, Pillman. No. 70.
Pieces, 12.
Symbol, No. 9 D. G. washer studs.

Time.	Hours.	Dates.		
Began	1.30 P. M.	5-19-96		
Ended	11.00 A. M.	5-21-96		
		Rates.	Wages.	
		Cts.	$	Cts.
Limit	24			
Actual	18½	9½	1	69
Premium	5½	3		17
Employee's earnings			1	86
Cost per piece				15⅛

Correct: ANSLEY, Foreman.

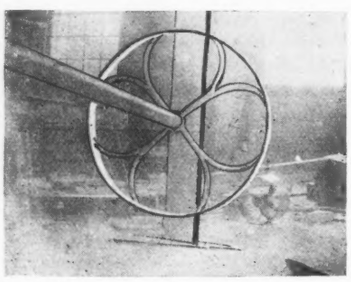
Approved: W. S. ROGERS, Superintendent.

Read instructions and keep correct time on back of this ticket.

* * *

PRIMITIVE MILLWRIGHTING.

The accompanying sketch shows a bit of millwrighting which fell a victim to the wicked kodak, in a little sawmill in Massachusetts. They were rigging up for a small lathe, and the scantling shown in the center was the handiest place to tie to, so a hole was bored in it for the shaft bearing at that end. The same scantling also helped to keep the upper story from getting too well acquainted with the cellar, and so was made to do double duty. The other end of the shaft was supported by an inverted hanger, and was not hypnotized into good behavior, as might be imagined from the view. While the coefficient of friction may be above the normal, it is safe to say this will probably run for years without difficulty—providing it doesn't shake down the scantling in the meantime.



PRIMITIVE MILLWRIGHTING.

* * *

NOTES FROM NOTOWN.—15.

ICHABOD PODUNK.

JONES'S DILEMMA—APPRENTICESHIP IN GENERAL.

We are having a spasm of the "good old apprentice" system in town, as a result of a little rivalry in the "bicycle parts" business, which has invaded even Notown. Jones hired a few boys to run his screw machines, and he had several who were pretty bright chaps, even for Notown. He had some rather peculiar work that none of the regular machinists in town had been used to, and he conceived the bright scheme of breaking in some of his boys, "training them to do his work, and then he would have just the men he wanted," and incidentally, the boys could be hired for about half what the men could and be saving dollars for Jones till they were 21, then he would have to pay them men's wages, or—hire more boys and break them in as he had done before.

Things went on swimmingly until Smith, another maker of "parts," heard of the plan and also that Jones's boys were hustlers. So he offered them two dollars more a week and got them, as a matter of course. Then Jones was mad—also as a matter of of course—but there was nothing to do but break in a new lot of boys, or hire men or—but this could not be thought of—pay the boys as much, or more than Smith did.

Another lot of boys were broken in amid lectures of fidelity and the debt of gratitude for teaching them the trade, etc. Brown is another maker in this line, farther down the street, and when he heard of the Jones and Smith case, he laid low for the next crop of boys, and when they were ripe in experience he picked the lot at a slight advance, leaving Jones in an unenviable frame of mind, and his shop minus some well trained boys.

Smith and Brown both say they can't afford to train apprentices; that they can hire them after they are trained, cheaper than to train them, and there are lots of men of the same mind. Jones says he can't hire men to suit him and thinks he must train them, but he wants a law passed to prevent anyone else hiring a boy he has trained, or the boy from leaving before he is twenty-one years old. Says he can pay journeymen as much as anyone, but he don't think it's fair for others to steal his apprentices. Brown and Smith say they have a right to hire whoever they can get, and buy labor the same as they do steel, the best they can for the least money, and add that "it doesn't pay to buy poor material, either labor or steel."

This is in a great measure the position of many other shops on the apprenticeship question, and the sooner it is settled in a sensible manner, the better for the machine business. There's one thing certain, some one must train apprentices, and the better they are trained the better mechanics will be the result. It seems reasonable to suppose that the boys Jones trains are worth more to him than to anyone else, as they are well acquainted with his work, which is a little peculiar, yet he never thought of offering them as much as Brown or Smith would pay. If they were worth two dollars more to Brown and Smith, they probably were to Jones, and it would have been cheaper to have paid this than to train others, especially with work all piled up waiting for workers.

It is more than likely that if the builders of the "Hustlers' Delight" wanted to use all of Jones's specialties and would pay more than the "Scorcher" people for them, that Jones would unfeelingly sell exclusively to the former, even though the latter had given him the first order, which induced him to go into the business. It's just like this: unless there is some contract which prevents, anyone will, other things being equal, sell their product, whether labor or patent pedal pins, to the highest bidder. And when Jones hired a boy, with the privilege of firing him on a minute's notice if he didn't like him, he didn't know human nature, or justice either, if he supposed the boy would not leave on the same notice, if he had a chance to better himself. It is better for all concerned to have a time notice before leaving, as it saves confusion in the shop as well as wear and tear on the mental machinery due to getting fired just before you get money enough saved for a bicycle or to start housekeeping with. This simply means a little consideration on the part of both employer and workman, and will be beneficial to both.

I know of one shop which has a very good system of apprenticeship. They take a boy on trial, if he proves satisfactory they take him on a three years' apprenticeship at fixed wages each year, but either party can annul the contract on due notice, so that if a boy is dissatisfied he can leave, or if not satisfactory he can be got rid of. They have learned that it isn't economy to keep a boy who wants to go, as his work isn't apt to be improved by lack of attention. At the end of his "time" he gets regular shop wages, if he stays, which he usually doesn't, as the apprentices of this shop are in demand at better wages elsewhere. The reason is that this firm can't keep all the apprentices they turn out, even if they wanted to—haven't room for them, as they keep a lot of boys going through the mill all the time.

Jones would probably ask why they trained boys for other shops. Well, they do it because it pays them, for they are not a charitable institution by any means. They give the boys a chance at all the work in the shop and keep them long enough at each part to become good workmen, and here is where the

money comes in. After a few weeks of instruction at any work, a bright boy can turn out a lot of work, and as a rule will hustle along, with a little encouragement, and come pretty close to equaling a man who is probably getting double the pay. This makes a rapid workman and also considerable money in the firm's pocket. Of course a boy cannot expect to learn a trade and get all that his work is worth during his apprenticeship, unless he will also pay for all work not up to the standard, and few will object to working at less than regular wages while mastering the trade, but it would be better for all concerned if a good plan could be introduced to give him a fair portion of his earnings. The premium plan as proposed by Mr. Halsey and enlarged on by Mr. Rogers, in April, seems to present a good solution, depending on the fairness of both sides, principally the employer. This can be applied to the apprentice during his last year or years, and will stimulate him into doing his best, and this means a larger output for the same plant. I'm going to try and talk Mr. B. into this premium plan myself, and see if Podunk can't get enough together to buy a bicycle too.

* * *

BY THEIR FRUITS SHALL YE KNOW THEM.

SLOW PAY.

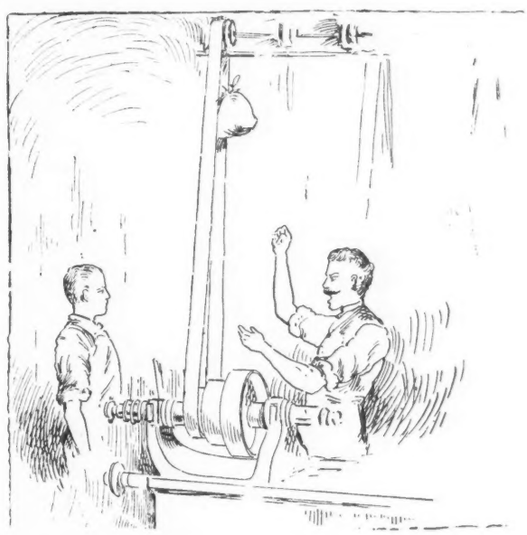
I SHOULD be sorry to make any suggestion that would open any avenue for more deviltry than the average apprentice boy practices, but the trick of fastening a paper bag full of sawdust, or iron or steel chips, or something of the sort to the upper part of the lathe belt, when the one running the lathe is temporarily absent, so that he gets "a dose" when he comes back and starts the lathe, is so venerable and well known, that no harm can come of mentioning it here in connection with the moral which this true story contains. Incidentally this trick is a good thing, "inasmuch" (as Josh Billings said about the tight boots) as it is an inducement for a man to stick to his lathe instead of loafing around the shop.

This particular apprentice boy was a particularly bright apprentice boy, as will presently appear, but he was so busily engaged in fastening the bag on the belt that he didn't notice the boss (who was called "The Skipper," this being in a New England shop) over behind a post, watching the proceeding. Instead of coming over at once and stopping the little game, "Skip"

waited, getting madder and madder every minute, until the bag was adjusted, the ladder put away and the boy back at *his* lathe at work, where of course he should have been all the time. Then "Skip" came over and there was a case of "a lad and a ladder" that the apprentice boy hadn't anticipated.

"Here, you," said "Skip," interpolating a large number of theological expressions, which better not be printed, in the course of his remarks; "you go and get that ladder and go up there and take down that bag, and then you put that ladder back, and then you wash up, and then you go home, and you *stay there.*"

It will be seen that "Skip" was so excited that his syntax was faulty from using more words than necessary, even not counting

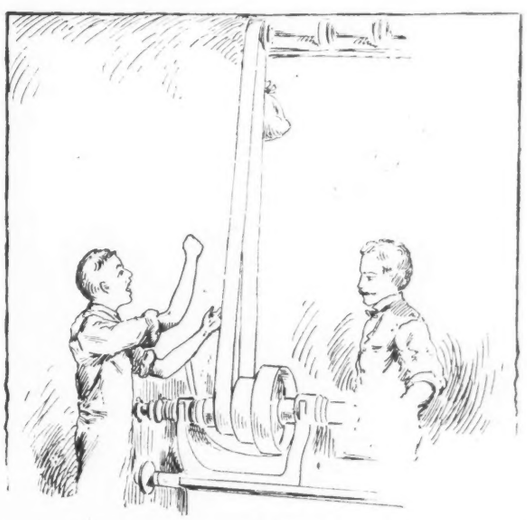


the theological words not quoted, and this shows the advantage of "counting twenty" before speaking, when "real mad."

Then the apprentice boy looked up into "Skip's" face and grinned, actually grinned; you see the apprentice boy wasn't mad, and could see just where the "Skip" had slopped over; then the boy made some remarks himself, something like this:

"Skip, I will take the bag down, *or* I will wash up and go home, *but I will be whizzlety gol dusted to Jude, if I do* BOTH."

Maybe you think the boy was sent home? Not much. This "skipper" knew his business, even if he did slop over occasion-



ally, and he said to himself, that a boy bright enough to keep his head and get the best of the matter in such a way, was too bright for the company to lose; and as the "Skipper" was working for the interest of the company instead of for his own personal glory, he has kept the boy until this day, and the boy is one of the best men in the place to-day.

See the moral? I know lots of "skippers" that *ought* to see it.

* * *

A NEW magazine has made its bow to the reading public, its name being *Baker's Railway Magazine*, published in the Metropolitan Building, New York. It intends to deal with the construction, equipment, operation and maintenance of railways, and its first issue contains some very interesting reading, by Mr. Baker and others. We wish it success, as well as that Mr. Baker had adopted a standard size instead of 6¾ x 9½ inch, which, to use the old saw, is "neither codfish nor sole-leather."

STEEL GEARING.

R. GRIMSHAW.

It being highly desirable, in gearing, to use a material which shall combine maximum degrees of hardness, strength and resistance to abrasion, for a given weight and dimensions, we find an admirable substitute for the cast iron usually employed, in unforged cast steel properly proportioned and worked.

Its tensile strength is about four times as great as that of cast iron, a highly desirable feature; but it has one marked disadvantage: that is, its high melting point (1 500° to 1 600° C.=2 732° to 2 912° Fahr. as against say 1 330° C.=2 426° Fahr. for cast iron) obliges the use of moulds made of very refractory material, which becomes baked by the melted metal, and by resisting its contraction on cooling, induces in the casting certain internal molecular strains, impairing its strength.

As cast steel shrinks $\frac{1}{56}$ in cooling (as against $\frac{1}{96}$ for cast iron), these strains are often excessive. They may be reduced by an annealing process. In this the carbon of the steel is not oxydized as is the case when cast iron is annealed in manufacturing malleable iron castings; but the combined carbon is in part set free in the "graphitic condition" (especially where the carbon percentage is high). It may be recombined by heating to redness and quenching in water, especially if the carbon is in high proportion. In considering the dimensions of the various elements in steel gearing, it is first proper to get the proportions of the parts among each other. Fairbairn notes this as a good scale of proportions:

Pitch line to point	=	circular pitch	× .35
" " " root	=	" "	× .4
Thickness of tooth	=	" "	× .45
Working depth	=	" "	× .7
Width of space	=	" "	× .55
Whole tooth depth	=	" "	× .75
Clearance at bottom	=	" "	× .05

and the average width of face is probably twice the circular pitch.

The wider the face the more durable the tooth, because the stress and abrasion are distributed over a greater area. The face width should never be less than a pitch and a half.

Mr. Henry Foster, of the Newburn Steel Works, Newcastle-on-Tyne, England, communicates to me the results of his experience in the matter of dimensions of cast steel gears, and I give them here on his authority, as good examples of varied and successful practice.

If we suppose the safe working load for cast iron in tension to be 4 500 pounds per square inch, and that for cast steel 18 000 pounds, the effective tooth width to be 1.05 times the circular pitch, in inches, the effective length .53 times the pitch, and the effective thickness of the tooth (after allowing for *wear*) .35 P, we will get as the safe working load, using the formula—

For cast iron:

$$W = \frac{4\,500 \times 1.06 \times (.35)^2}{.53 \times 6}$$

For cast steel:

$$W = \frac{18\,000 \times 1.06 \times (.35)_2}{.53 \times 6}$$

these values of W being 183.75 times the square of the circular pitch, for cast iron, and 735. times the square of the circular pitch for cast steel; assuming all the strain to come on one corner of the tooth, an extreme case.

If, however, we consider that the teeth are properly made and the wheels properly presented together so that the stress will act all along the tooth width, we have—

For cast iron:

$$W = \frac{4\,500 \times 2 \times (.35)^2}{.75 \times 6} = 244.8$$

times the square of the circular pitch in inches.

For cast steel:

$$W = \frac{18\,000 \times 2 \times (.35)^2}{.75 \times 6} = 979.2$$

times the square of the circular pitch in inches.

If more than one pair of teeth are supposed to be in mesh at once, as where the number of teeth is great, the strength of the gears will be still greater, probably about one half more. As a general statement, it may be said that a cast steel gear wheel is as strong as a cast iron one of twice the pitch.

We will lay down two pairs or sets of formulas: one where only one pair of teeth is supposed to mesh, as in crushers, etc., where foreign substances are likely to get in the gears (see A and B), and the other where it is not likely to occur (C and D):

(A) Cast iron, rough usage.

$$H = \frac{P^2 \times 183.75\ V}{33\,000} = P^2\ V\ .00556$$

$$V = \frac{H}{P^2\ .00556}$$

$$P = \sqrt{\frac{H}{V\ .00556}}$$

(B) Cast steel, rough usage.

$$H = \frac{P^2 \times 735.\ V}{33\,000} = P^2\ V\ .02227$$

$$V = \frac{H}{P^2\ .02227}$$

$$P = \sqrt{\frac{H}{P^2\ .02227}}$$

(C) Cast iron, careful usage.

$$H = \frac{P^2 \times 244.8\ V}{33\,000} = P^2\ V\ .007416$$

$$V = \frac{H}{P^2\ .007416}$$

$$P = \sqrt{\frac{H}{V\ .007416}}$$

(D) Cast steel, careful usage.

$$H = \frac{P^2\ 979.2\ V}{33\,000} = P^2\ V\ .02966$$

$$V = \frac{H}{P^2\ .02966}$$

$$P = \sqrt{\frac{H}{V\ .02966}}$$

In the foregoing, H represents the number of horse powers to be transmitted, V the velocity in feet per minute at the pitch line and P the circular pitch in inches.

To make the formulas a little more easily understood for those unaccustomed to working with formulas, I will state some of them (see A) at length:

To get the horse power which a given cast iron gear will safely transmit where only one tooth may be in mesh, divide 33 000 into the product of the square of the circular pitch in inches, the velocity in feet per minute at the pitch line, and 183.75; or what is simpler, multiply the square of the circular pitch in inches by the velocity in feet per minute, and by .00556.

To get the velocity in feet per minute, at the pitch line, in cast iron gear wheels where only one tooth receives the strain, divide the horse power to be transmitted, by .00556 times the square of circular pitch in inches.

To get the circular pitch in inches of a cast iron gear wheel, to transmit a given horse power at a stated velocity in feet per minute at the pitch line, where only one tooth receives the strain, divide the required horse power by .00556 times the velocity in feet per minute at the pitch line, and take the square root.

We will now take a few examples in cast iron and in cast steel:

How many horse power can be carried by a cast iron spur gear of 60 teeth, one inch circular pitch, making thirty turns per minute?

The circumference is 60 inches = 5 feet, the pitch line velocity $5 \times 30 = 150$ feet per minute, and the horse power that it will safely transmit, allowing only one tooth to get the strain, will be:

$$1^2 \times 150 \times .00556 = .834 \text{ HP.}$$

If, however, more than one tooth gets the strain, we may say that it will safely transmit $1^2 \times 150 \times .007416 = 1.1124$ HP.

Making a similar wheel out of cast steel, it will under the same conditions transmit $1^2 \times 150 \times .02227 = 3.34$ HP., where only one tooth gets the strain; and

$1^2 \times 150 \times .02966 = 4.449$ HP. where the strain is more distributed.

Now if it be required to know how fast a 60 toothed cast iron wheel of 1 inch circular pitch would have to turn to carry twenty

horse power safely, with only one tooth getting the stress, we have the required speed at the pitch line

$$\frac{20}{1^2 \times .00556} = 3\,533 \text{ feet per minute,}$$

and as the circumference of the wheel is

$$\frac{60 \times 1}{12} = 5 \text{ feet,}$$

the rotation speed would be

$$\frac{3\,533}{5} = \text{say } 707 \text{ turns per minute.}$$

When more than one tooth receives the stress, the pitch line speed will be

$$\frac{20}{1^2 \times .007416} = 2\,696 \text{ feet,}$$

giving a rotation speed of

$$\frac{2\,696}{5} = \text{say } 539 \text{ turns per minute.}$$

If the wheels were of cast steel, the speed can be slower; thus, for instance, if only one tooth got the strain, the velocity of the pitch line would be

$$\frac{20}{1^2 \times .02227} = 898.1 \text{ feet per minute,}$$

corresponding to

$$\frac{898.1}{5} = \text{say } 175.6 \text{ turns per minute.}$$

Where there are more teeth in mesh it need be only

$$\frac{20}{1^2 \times .02966} = 674.2 \text{ feet per minute} = 134.8 \text{ turns per minute.}$$

The speeds calculated for the cast iron wheels would prove to be excessive, and either a coarser pitch would have to be adopted or a wider face used.

The most important problem, however, is what circular pitch to give where the horse power and the velocity are given.

In the case of cast iron wheels 30 inches diameter, with only one tooth working at a time, the pitch to get 30 horse power with 80 turns per minute would be (as the velocity of the pitch is

$$\frac{80 \times 30 \times 3.1416}{1.2} = 628.3 \text{ feet per minute)}$$

$$\sqrt{\frac{30}{928.3 \times .00556}} = \sqrt{\frac{30}{3.4873}} = \sqrt{8.60} = 2.93$$

inch circular pitch.

In this case, 3 inch circular pitch would be used and the wheel would transmit

$$\frac{30 \times 3.}{2.93} = 30.7$$

horse power at the stated speed of 80 turns per minute.

Where more than one tooth at a time get the strain, the pitch of the cast iron wheel would have to be only

$$\sqrt{\frac{30}{628.3 \times .007416}} = \sqrt{\frac{30}{3.758}} = \sqrt{6\ 39} = 2.52$$

inch circular pitch. In this case 2½ inch pitch would doubtless be used and would carry the same horse power.

With the cast steel wheels, the pitches in the two cases would be as follows:

With one tooth gearing:

$$P = \sqrt{\frac{30}{628.3 \times .02227}} = \sqrt{\frac{30}{13.99}} = \sqrt{2.144} = 1.46$$

inch circular pitch; in which case 1.5 inch would be used and would carry

$$\frac{30 \times 1.5}{1.46} = 30.8 \text{ HP.}$$

With two teeth of each wheel gearing:

$$P = \sqrt{\frac{30}{628\ 3 \times .02966}} = \sqrt{\frac{30}{18.635}} = \sqrt{1.073} = 1.034$$

inch circular pitch, in which case one inch would be used and would transmit

$$\frac{30 \times 1}{1.034} = 29.013 \text{ HP.}$$

All the above formulas suppose the teeth proportions according to the Fairbairn figures quoted at the beginning of this article.

As regards the proportions and dimensions of the various parts of the wheel proper, we have them as follows, the figures for cast iron being according to Box and those for cast steel according to Foster:

Elements.	Cast Iron.	Steel.
Thickness of rim.....	Same as tooth thickness.	$P \times .375$
Width of arm at rim.....	$\sqrt{7.34 \times P \times F \times \sqrt{n}} + L$	$\sqrt{\frac{P \times 2\,R}{L}} + .4$
Width of arm at hub.....	Taper on arm ½ to ¾ per ft	R x .04 wider than at rim.
Thickness of arm	$P \times .45$	$\frac{7\,P}{20} + .1$
Thickness of rib on arm*...	$P \times .25$	$P \times .25 + .1$
Width of inner rib at rim..	$P \times .66$	$P \times .56$
Width of face of rim.....	$P \times 2.5$	$P \times .2$
Length of hub.....	Radius x $.06 + \frac{5\,P}{2}$	Radius x $.06 + \frac{5\,P}{2}$
Thickness of hub.....	$\frac{7\,P}{9} + \frac{1}{8} K$	$.3 \sqrt{(R \times P^2)} + .375$

* Supposing cross shaped sections for arms.

The weights of a wheel 4 feet ⅜ inches diameter, with dimensions according to the above formulas, are given by Foster as, in cast iron, 595 pounds; in cast steel, 172 pounds; being a saving in weight for the cast steel of

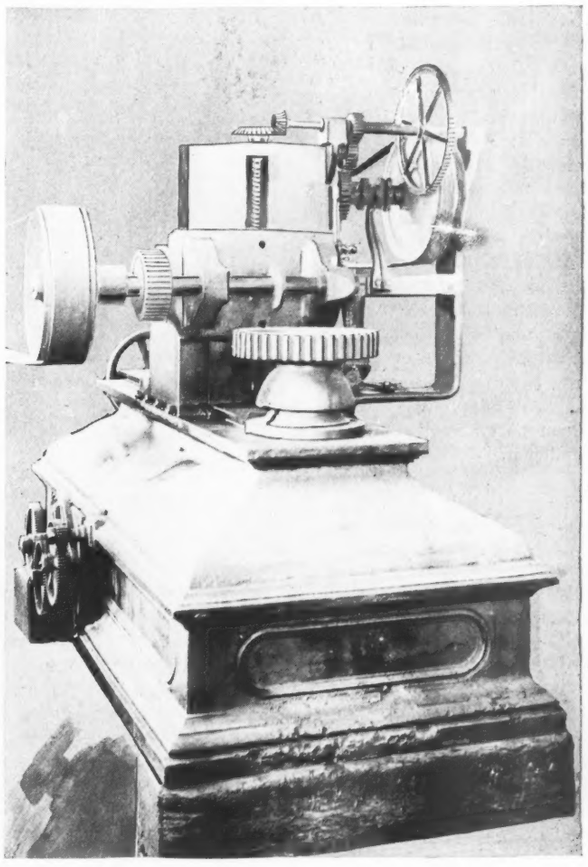
$$\frac{595 - 172}{595} = 71 \text{ per cent.}$$

But in actual practice the pitch is made thicker than by the formulas, to allow for thinning of the teeth by wear, and making all this allowance, the saving in weight is 40 per cent. in favor of the cast steel gear.

* * *

AN OLD AUTOMATIC GEAR CUTTER.

It is but natural that New England, being the part of the country first settled, should have first used and made machine tools, and the relic hunter can find much to please his fancy. It must



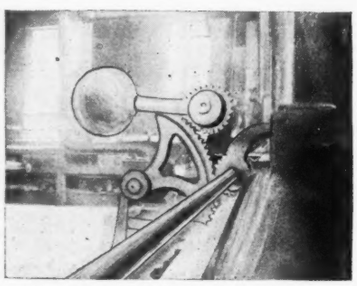
FULL AUTOMATIC GEAR CUTTER, MADE ABOUT 1860.

not be supposed, however, that New England shops have nothing but the old tools, or that all of them preserve them, for such is far from being the case, as a visit to the leading shops will soon make plain to anyone. And it is not the antiquity alone which

makes an old tool interesting, but the principles involved in its operation; and while some of these have long ago been discarded, others are still used and have probably been patented several times by different parties.

One of the early New England shops was that of Gage, Warner & Whitney, of Nashua, N. H., and though none of the original men are now alive, some of the tools they built prove beyond doubt their ability as ingenious mechanics. The gear cutter shown herewith is one of their tools, and was built previous to 1860; the exact date could not be learned. The combination of poor light and the inability to secure the desired kind of plates, prevented the photograph from being all that could be desired, still the main features of the machine can be seen quite plainly. The great feature of this old machine is that it is entirely automatic, so that when started on a gear blank it kept on, cutting, spacing and cutting again, until the gear was completed. Its main difference from the modern machines, so far as the automatic feature goes, was the absence of an electric bell. It is said, on pretty good authority, too, that when a lawsuit was imminent between two of the leading makers of gear cutters, one of them happened to go into this shop and saw this machine. Then he had a draftsman make drawings of its mechanism, sent a copy of them (so the story goes) to the other maker, and the suit was called off, saving money for both parties. The old machine had the very principle that was in dispute. Whether this story is true or not, it's a good object lesson, and if it isn't true, it ought to be.

There is little to explain about the mechanism. The cutter is driven by gearing from the belt at the left. The feed is obtained from the gear train on the right, and the reverse for the back motion of the cutter, is caused by the "throw-over" arm at the right of the cutter spindle. This throws a clutch above into one or the other position. The small view, snapped with a pocket kodak, shows the detail of the "throw-over" clutch. The feed is connected with the lower horizontal shaft which engages a segment of a rack and the weight shown. The downward feed revolves the shaft and raises the weighted ball. When this passes the center it drops to the other side and throws the clutch to the other position, feeding the cutter back for the next tooth. Then the spacing occurs and the operation is reversed for the next cut.



REVERSE OF FEED, OLD GEAR CUTTER.

As will be seen, the cutter head can be adjusted on the bed by a screw running underneath, the hand-wheel being shown at the back. This adapts it to a wide range of work, as gears of large size can be cut, eight feet in diameter being the limit, as I remember it.

* * *

PATENTED AND UNPATENTED BOILER SETTINGS.

F. G.

There are in use—quite extensive use, some of them—a variety of patent boiler settings, neither better nor worse, of course, for being patented. Some of these are very good indeed when kept strictly to their purposes, but none of them can in reason be expected to accomplish all purposes. They save in one way and not infrequently pay for it in another. If the saving is in the direction of greatest importance and the line in the direction of least importance it is all right. If the reverse is true, it is not so well.

If one is handling the best patented boiler setting in the world, he is likely to run right up against some old setting that will give his 25 per cent. saving-of-fuel guarantee, lots of trouble. He may lose, while if he had agreed to do more work, or to use an inferior kind of fuel, everything might have been entirely satisfactory.

There are three ways in which a boiler setting may prove its superiority. One of them is in the direct saving in the quantity of fuel burned to do the work being done with the setting which it supplants, another by enabling more work to be done by a boiler, and the third by enabling cheaper fuel to be used. Of course, there are other ways in which the new setting may be advantageous, but there is no intention of going into detailed merits of different boiler settings. In either of the directions named the "improvement" may be important, but scarcely in all unless the new setting supplants a very poor one, which leads to the remark that *all* old time boiler setting is not poor boiler setting, as is sometimes taken for granted. In fact, a man engaged in introducing a boiler setting, naturally enough finds it advisable to look rather carefully at what kind of a setting he is replacing. In some cases it would scarcely be possible to get together anything worse, while in the other cases they are hard to beat.

I remember a case in which a party representing a company extensively engaged in boiler setting guaranteed to effect a large saving in fuel; 25 per cent., as I remember. A contract wasmade to re-set three boilers. The existing setting was good but old, though kept well patched up. A test was made with the boilers as they were, then they were re-set—the new setting was applied and another test was made. Both parties in interest were represented, each by a competent engineer. After the boilers were re-set more coal was burned in doing the same work, than before. This was beyond question, but it was equally beyond question that more work *could* be had from the boilers than before re-setting. But more work was not required. The contract called for the use of less coal for a definite amount of work and the setting had very clearly lost.

In another instance a party introducing his own patent setting applied to a manufacturer to reset his boiler, five feet in diameter, he also agreeing to show a very substantial saving in fuel. He was an honest appearing man and was given pretty much his own way. The work was fairly constant and the coal burned for two days was observed to the satisfaction of all parties, then the new setting was applied and similar observations were made. Nothing in the way of an absolutely accurate test was attempted in either instance, but the tests were sufficiently accurate to satisfy all parties. The party who re-set the boiler watched the performance very carefully, and the last night, that is the night after the last day's trial, sometime between quitting time and morning, gathered his belongings together and left. He had set the boiler very well indeed, but not so well as it was originally set. He never came to the works again, or sent in a bill.

Men with patent boiler settings have taken advantage of the hap-hazard settings that prevail, which is altogether proper. But all boiler setting is not vicious, I mean all that are not patented, and occasionally one is encountered that cannot be improved very much *in the direction desired.* That is a good one to let alone.

This is not in the way of saying anything against patent boiler settings. Their use has saved coal, and it has helped to educate a good many who ought to know, up to the point of knowing that while boiler setting is mainly a matter of common sense, there are in it what may be called *critical points*, just as there are in about everything. Points that must be be attended to or results will be materially influenced.

* * *

SYSTEM IN THE DRAFTING ROOM.

JAMES C. HEMPHILL, C. E.

System in the drafting department with which I am connected, is the result of necessity. Many of the older drawings are on odd pieces of paper and occasionally both sides are used, and many of the later drawings were made without regard to system, often a single drawing on a sheet, the size of which was determined by the size of the drawing.

The result was that it became more and more difficult to find any desired drawing, and it was evident that some system must be employed whereby the drawings could be kept in better order and more easily referred to.

The first thing evident was the necessity of a standard size of sheets.

One draftsman, who was working on a small machine, used a size of sheet which was right for his purpose, but it was found too small for general use. Therefore a catalogue of engineering supplies was consulted to see what the regular sizes of drawing papers are and it was decided that the size called "Double Elephant," would be about right, but there was such a difference in the sizes given for "Double Elephant" of the different qualities of paper, that it was difficult to decide upon a size which would cause no waste of either paper or tracing cloth. The sizes

given were 26x40, 27x40, 30x40, 29x42, 27x42, etc. This latter being a size of prepared blue print paper, and many of our drafting books being 30 inches wide, and as tracing cloth was given as 40, 42 and 43 wide, it was decided to adopt 26 x 41 as the standard sheet. Drawings which require larger sheets were to be made whatever size necessary.

The size of standard boards was made 30x40 inches. The paper comes in rolls 62 inches wide. These are sawed in two before opening, thus giving rolls 31 inches long. There is some

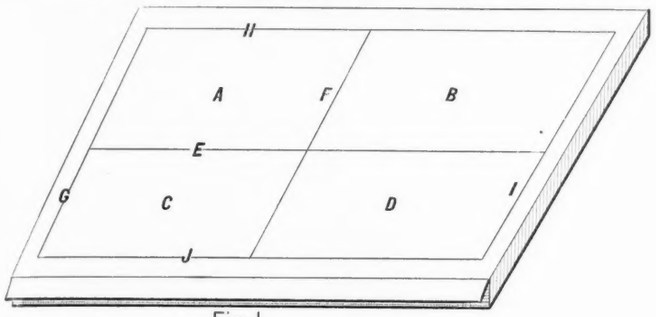


Fig. 1

waste here, but it is convenient to have a little space at the top and bottom of the board, and it is desirable to have enough paper to turn down at the bottom, giving a smooth edge for the vest of the draftsman to rub against. The paper is dampened and glued at the edges. The glue usually takes about ½ or ¾ of an inch all around the board so that, considering the difficulty of working near the top and bottom of the board, this size of board is about right for a sheet to trim to 26 x 41 inches.

Before beginning a drawing, the size of the finished sheet is marked out as shown by the lines G H I and J (Fig. 1). If the drawing will not require a whole sheet, the lines E and F are also drawn, dividing the sheet into quarters, A, B, C and D.

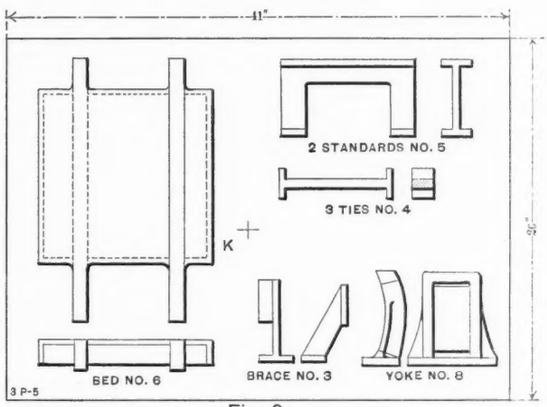


Fig. 2

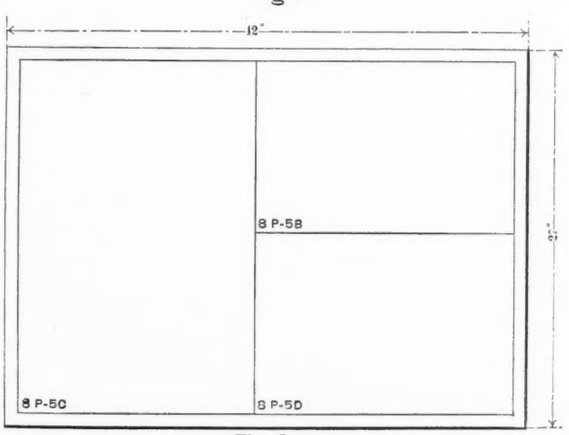


Fig. 3

These quarters are 13x20½, and it is a rule that when practicable no drawing shall cross the lines F or E and be located in two quarters, the plan being to keep the quarters independent, especially if the sheet is to be traced for blue printing as 13x20½ is the standard shop size of sheet. All drawings must be cut or folded to this size, the drawers in the shop being suited to it. But if one quarter is not enough for the drawing it is preferable to use two quarters, one above the other as A and C or B and D. This will give a sheet 20½x26 inches, and if it is to be traced it is well to put but few figures, etc on the line E, as the blue print will be folded on this line. The quarters are to be considered as separate sheets, and are called A B C and D (Fig. 1.)

Fig. 2 shows a supposed case in which some details of No. 8 press are drawn, this being the fifth sheet. K indicates the center of the sheet, and is convenient for tracing, the lines upon which the print is to be cut being drawn on the tracing. Fig 3 shows how the tracing of sheet 8 P 5 is divided. Tracing cloth is purchased in rolls 42 inches long (that is the width of roll) and cut in sheets 27 x 42. It will be seen that in the lower left hand corner of each of the three parts into which the print is to be cut, the name of the machine, the number of the sheet and the part of the sheet is given.

Blue print paper is purchased in sheets 27x45 and 13½ x 21, and the prints are cut to 26 x 41, 20½ x 26 and 13 x 20½, and possibly 13 x 41. In the present case we should have two sheets 13 x 20½ and one 20½ x 26. The latter is to be folded to 13 x 20½.

Each casting of No. 8 press has a name and a number, which are written in a book ruled as shown in Fig. 4. Suppose we wish to find the drawing of tie No. 4; we see in No. 8 press book that it is on sheet 5 and on quarter B. By looking in No. 8 press drawer and looking at the lower left hand corners of the sheet till we come to the sheet 8 P-5, we know that we shall find tie No. 4 on the upper right hand quarter.

NO. OF PIECE	DRAWN FOR	NO. 8 PRESS NAME OF PIECE	SHEET	QUARTER	NO. WANTED
1	*	Side Frame R	3		
2	*	Side Frame L	4		
3		Brace	5	D	
4		Ties	5	B	3
5		Standards	"	"	2
6		Bed	5	C	
7	5P	Brackets			2
8		Yoke	5	D	
9					
10		Bed Clamps	6	B	4
11		Track	7		
12					
13					
14		Table	8	C	
15		Girts	8	D	2
16		Toggle Blocks	"	"	4
17					
18					
19		Rocker Shaft	9	A	
		*In Large Drawer No. 1			

Fig. 4

If we wish to find bracket No. 7, we find in the book that it is the same as is used on the No 5 press, and we can find on what sheet by looking in the No. 5 press book. If the sheets tend to roll up at the edges it is well to number them on their backs in the lower left hand corners.

It will be found convenient to have in each drawer a card upon which may be written the place of any drawing which has been taken out.

* * *

GERMAN MACHINISTS BUSY.

As an illustration of the advantage of having things settled and knowing what they are going to be the next year, and the year after that (whether the condition be the ideal one or not), I may state that every machine shop in Germany is busy "up to the ears," with orders far ahead. Messrs. Biesolt & Locke, large sewing machine manufacturers in Meissen, Saxony, wanted a 110 HP. steam engine. The shops in Gorlitz, Prussia, could deliver one (as a special favor, as the customer was personally introduced) in thirteen months. The next establishment tried wanted eighteen, and the next sixteen. At last a shop was found which got the order by promising delivery in six.

A firm in Ohrdruf, Thuringia, came to me to know where it could get an American turret lathe for instant delivery, as no German lathe-maker could deliver one under three months, and one wanted fourteen.

Germany is just *buzzing* with work, and not only that, is prospering and growing. ROBERT GRIMSHAW.

Dresden, Oct. 7.

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NOVEMBER, 1896.

CONTENTS:

The Old and the New	71	Old Automatic Gear Cutter	83
The First British Man-of-War	71	Patented and Unpatented Boiler Settings.....F. G.	84
Boiler Horse Power—Isometric Drawing.....“Thermal”	72	System in the Drafting Room, James C. Hemphill	84
From Actual Practice.....“Milo”	73	Editorials	86
Burr Portable Keyseater	74	Valves and Gears (1)....E. T. Adams	87
New Russian Locomotive Works	74	Here and There.....John Lookaback	89
A New Thermic Engine	76	Boring and Turning Mill	91
Notes from a Roving Contributor	77	New Shops of Baush & Harris Co.	91
Pattern for a Connecting Piece between two Different Shaped Pipes.....Geo. Guntz	77	Vertical Rack on Lathe	91
Wind.....Fred E. Rogers	78	Cast Iron Turning Tools	94
Labor's Value (3)..... W. S. Rogers	79	My Backwoods Professor (1), Jonathan Jones, Jr.	95
Notes from Notown, (15), Ichabod Podunk	80	Items of Mechanical Interest	96
By their Fruits shall ye Know Them, Slow Pay	81	How and Why	96
Steel Gearing.....R. Grimshaw	82	What Mechanics Think	97
		Manufacturers' Notes	98
		Fresh from the Press	98

One million, one hundred and twenty-six thousand, two hundred and fifty copies of the article entitled *Two and Two Make Four*, which appeared in the September number of MACHINERY, have been printed and distributed. Following our injunction "to pass this along," we find that some copies of the leaflet have been read by as many as twelve persons. Those that have been traced show an average of three readers to each leaflet, and if this average holds good throughout the entire issue, more than three million working men have read this article.

Three millions are a good many; about one quarter the entire vote for President in 1892.

THE VALUE OF BOOKS.

Books may perhaps be divided into two classes, one containing nothing but original matter, or information personally acquired by experiments; and the other, more or less of a compilation of matter already known, but either brought out in a different manner or with different applications, and probably tempered by the writers' experience. It is needless to say that books of the first named class are decidedly scarce, if indeed any exist in the strict application of the term "original," as we all depend to a great extent on the knowledge of others.

In the second class we meet with a large variety of books, from the well known Mechanical Engineers' Pocket Book by Kent, to others which are the merest literary hash; and yet the value of each to the reader depends more on the articles selected and the manner of compilation, than on the amount of original matter contained. There is hardly a text-book in existence which is not very similar to other text-books in the problems it contains, the difference being in the manner of presenting them to the readers; for the same principle can often be presented in ways so abstruse that an X ray would hardly pierce it, or in language that an ordinary mechanic can readily grasp; it's the same goose, served in different styles. Whoever takes a valuable principle, even if as old as nature herself, and clothes it in clear, understandable language, is a benefactor to those who are vainly trying to wade through the ordinary text-book. Even if the author is fortunate enough to secure a few shekels for his labor, it makes him no less a benefactor, for he has opened the gate to many inquiring minds. Whatever may be the literary verdict as to one who merely compiles the work of others, he has aided many if he compiles wisely and with care; if he gives credit to the authors of the articles used, he escapes the stigma of plagiarism.

* * *

EXPENSES AND RETURNS.

There is altogether too great a tendency in all branches of business to consider the amount of money expended, rather than the relation of the expenses to the returns. In the matter of wages, of advertising, or of other expenses of a business, it is too often the custom to limit the outlay to a certain number of dollars, rather than to make it proportional to the results obtained. If for example, a new foreman can double the output of a shop with very little expense, which can probably be done in more than one shop that is run on its past reputation rather than its present efficiency, it is economy to pay him double the usual rate rather than let him go to another shop; for by simply doubling his wages you have practically doubled the size of your plant—its effective size at least; and it is surely economical to increase expense in the way indicated if you can obtain the increased returns.

The same reasoning applies to advertising and other branches of a business; the amount involved is not the question at issue, it is the return as compared with the outlay that should be considered in either case. The fact that you are paying your foreman more than your neighbor pays his should not enter the question, it is the return he is giving for your money that is to be counted. The practice of having a fixed rate for foremen and shopmen generally is false economy and an injustice to the men. It deprives the workmen of ambition and tends to make clods of them; and although clods will answer on some jobs they don't turn out work that give shops a reputation.

Don't think because a man wants five dollars a day that he is a highwayman, or has an unreasonable desire to become a millionaire. See if his work is worth it as compared with that of other men, and if he is giving you 25 per cent more in return than the four dollar man, he is earning five dollars and it will be to your advantage to pay it willingly.

Perhaps you say that you will have no peace from the rest of the men unless you pay them the same then apply the same test and if they fail to pass they are not worth it; if they do, you are the gainer as well as they. If you can fill your shop with men who *earn* five dollars a day you will have the most efficient plant in the country.

* * *

VALVE GEARS.—1.

E. T. ADAMS.

There are few subjects which have taken so much space in the pages of the technical press, and in which so little new matter has been presented to the reader, as in this one subject of valve gears. Yet there are few subjects which are more eagerly studied today, not only by the new hands in the shop or engine room, but also by the veterans who have grown gray in the service of King Steam. There are few copies of any techhical paper that do not contain some problem relating to valve gears, and with a regularity that suggests the measured beat of a pendulum we find the more ambitious series of papers written to meet the ever present demand. There is much regarding this old subject that does not appear in books. It is part of the lesson which the older men among our readers have learned by experience; of this class the suggestions and criticisms are always of value and interest, and will form a welcome addition to the short series of papers of which this is the initial number. The writer hopes in this series to present, along with much that is old, some points which may be new, at least to most of the readers. The main effort, however, will be directed toward bringing out the *why* of each simple step, and thus laying a foundation on which each reader may erect for himself as complete a superstructure as his inclinations dictate.

When a single valve engine has been delivered to the purchaser, or set up on the testing bed at the works of the builder, the engineer who is to have charge of the plant, or the erecting man, as the case may be, gets out his indicator and regardless of any theories which obtain in the drafting room, he starts in "to equalize the cards." He will not get either equal lead or equal

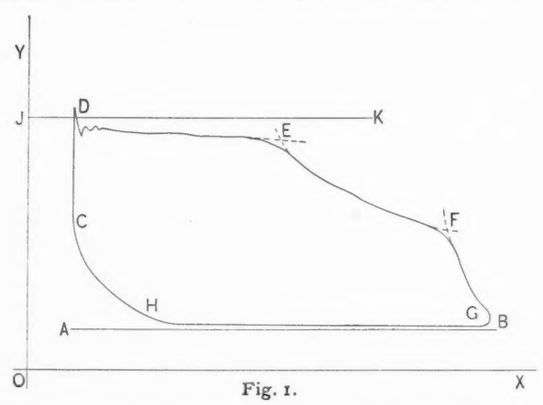


Fig. 1.

ACTUAL CARD FROM SIMPLE SLIDE VALVE ENGINE. DIAMETER, 10 INCHES; STROKE, 12 INCHES; REVOLUTIONS, 200; BOILER PRESSURE, 80 LBS. GAUGE.

cut-off, release and compression may not take place at exactly the same point in each stroke, but simply taking the valve as he finds it he will work out some compromise that will give, as near as may be, equal areas or equal work with "good cards" from each end of the cylinder. The form of the card will vary chiefly with the type of engine and its speed, but in all cases this principle holds true, that it is the *indicator* rather than the *valve diagram* which gives the true test of excellence in valve design.

Hence it seems reasonable to begin a study of valve gears with a study of the indicator card, and in taking up any type of engine, to decide first what will be the most desirable form of card, after which the problem will be to design the valve which will give the nearest approximation to this card for each end of the stroke.

The indicator card is nowadays so familiar to the men for whom these papers are written, that explanation is necessary chiefly to insure that the writer and the reader each give to the same thing the same name. Fig. 1 reproduces an actual card taken from a small slide-valve engine cutting off at one-half stroke. Fig. 2 is the theoretical card for the same engine. It will be noticed that the variations in the actual card from the theoretical are of such a nature that they can only be determined by actual experience with an engine of the type under consideration. Now it is very important for the designer to be able to modify the theoretical diagram to make it accord as closely as possible with the actual diagram which the engine will give under given conditions, and while, as we have intimated, nothing can wholly take the place of experience, we may give in the following papers some hints which should be of considerable assistance. The following explanation of the terms used is taken mainly from the catalogue of the Crosby Manufacturing Co.:

The atmospheric line A B. Figs. 1 and 2, is a line drawn by the pencil of the indicator when the connections with the engine are closed and both sides of the indicator piston are open to the atmosphere. This line represents on the card the pressure of the atmosphere or the zero gauge pressure.

The vacuum line O X is a reference line usually drawn about 14.7 pounds by scale below the atmospheric line. It represents

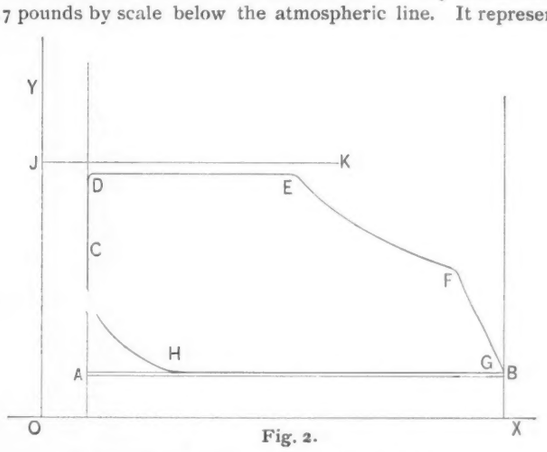


Fig. 2.

THEORETICAL CARD. DATA THE SAME AS FOR FIG. 1.

a perfect vacuum, or the absence of all pressure. The distance *O A* is the pressure of the atmosphere, as shown by the barometer at the time the card is taken by the indicator.

The clearance line O Y is another reference line drawn at a distance from the end of the diagram equal to the same per cent. of the length of the diagram that the clearance or waste room is of the piston displacement. The distance between the clearance line and the end of the diagram represents the volume of the mechanical clearance together with the waste room of ports and passages at the end of the cylinder.

The line of boiler pressure J K is drawn parallel to the atmospheric line, and at a distance from it by scale equal to the boiler pressure shown by the gauge. The difference in pounds between it and D E, Fig. 1, shows the loss of pressure due to the steam pipe and the ports and passages of the engine; D E, in Fig. 2, represents the assumed pressure in the steam chest. In this case it is taken as 5 pounds lower than the boiler pressure.

The admission line C D shows the rise of pressure due to the admission of steam to the cylinder by opening the steam valve. If the steam is admitted quickly when the engine is about on its dead center this line will be nearly vertical.

The steam line D E is the point where the admission of steam is stopped by closing the valve. It is difficult to determine the exact point at which cut-off takes place. It is often located where the expansion curve produced upward cuts the steam line produced. See dotted lines in Fig. 1. The expansion curve E F

shows the fall in pressure as the steam in the cylinder expands doing work. This is assumed to be a rectangular hyperbola in Fig. 2.

The point of release F shows where the exhaust valve opens.

The back pressure line G H shows the pressure against which the piston acts during the return stroke. On diagrams taken from non-condensnig engines it is either coincident with or above the atmospheric line as in Figs. 1 and 2. On cards from condensing engines, however, it is found below the atmospheric line at a distance greater or less according to the vacuum obtained in the cylinder. In Fig. 2 a back pressure of 1.3 pounds above atmospheric pressure is assumed.

The point of exhaust closure H is a point where the exhaust valve closes. It cannot be located very definitely, as the change in pressure is at first due to the gradual closing of the valve.

The compression curve H C shows the rise in pressure due to the compression of the steam remaining in the cylinder after the exhaust valve has closed.

The mean effective pressure M. E. P. is the average or mean unbalanced pressure urging the piston forward.

The simplest possible form of card and the one calling for the simplest form of valve is shown in Fig. 3. There is no expansion curve. Cut-off E and release F take place at the same instant, just at the end of the stroke. A steam pump gives a card much of this form, but it indicates conditions which are very undesirable for the engine. In order to show why, and also that we may take the simplest possible case first, let us assume that we are to design a valve to give this steam distribution for a 10 x 12 simple non-condensing engine, to make 30 revolutions per minute using steam at 80 pounds gauge pressure at the boiler, clearance 10 per cent.

To draw the theoretical indicator card, we may first decide on the length of card desired. The actual indicator card will usually

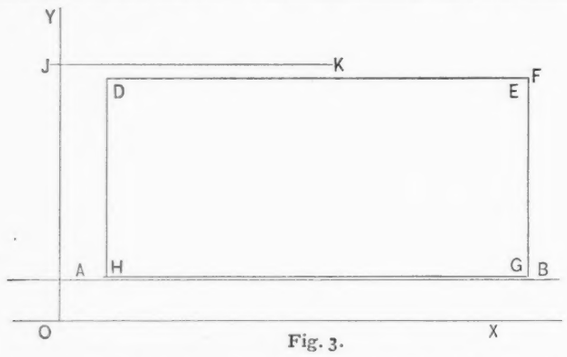


Fig. 3.

be from 3 to 4 inches long, and the latter will be a convenient length to assume. If we use a 40 scale, $\frac{1}{40}$ inch representing one pound pressure, we will have a card of the same size that we would obtain with the indicator using a 40 spring.

Referring to Fig. 3, draw the vacuum line O X 5 or 6 inches long, and the atmospheric line of the same length 14.7 pounds to scale (that is, nearly $\frac{15}{40}$ inch) above O X. Draw F B for the end of the card and laying off 3 inches to the left along O X, draw H D. This is the admission line. The clearance was to be 10 per cent. Hence, since a line 4 inches long represents the volume swept over by the piston, 10 per cent. of 4 inches or a line $\frac{4}{10}$ inch long will represent the clearance. Laying off $\frac{4}{10}$ inch to the left from H along O X, draw the clearance line O Y. Now a steam gauge shows pressure above the atmosphere. Accordingly if we lay off 80 pounds (2 inches) to scale above the atmospheric line, we locate J K, the line of boiler pressure. Now steam will not flow along a steam pipe unless there is a difference in pressure between the two ends, hence the pressure at the steam chest will be lower than at the boiler. If the steam pipe is long, or has many sharp turns, or if it is too small to carry easily the volume of steam used by the engine, this fall in pressure may be considerable. In this case, although the engine takes steam for the entire stroke, we have assumed that it is turning very slowly and the fall in pressure should not be great. We will assume that it is 5 pounds; this makes the steam chest pressure 75 pounds gauge, and laying off this pressure above the atmospheric line, we have the steam line D E. The line E G represents the fall in pressure within the cylinder at the end of the stroke, hence it only needs the back pressure line G H to complete the card. Now to force the exhaust steam out against atmospheric pressure, the piston must exert a force equal to the pressure of the atmosphere and enough more to overcome the friction of the exhaust steam when flowing through the ports and passages leading out to the air, this excess above atmospheric pressure should never be large. We will assume in this case that it is $1\frac{8}{10}$ pounds, and laying off this distance to scale above the atmospheric line we have the back pressure line G H, and D E G H is the complete card. After designing the valve we will see what modification, if any, should be made in this theoretical card to make it correspond more nearly with the actual card.

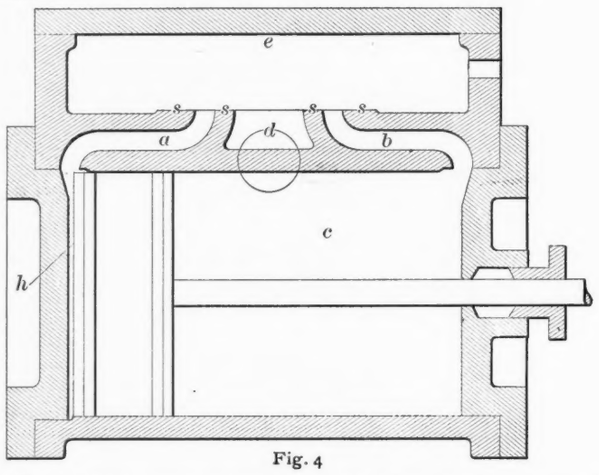


Fig. 4

Fig. 4 shows a section through the cylinder and steam chest of of the engine for which we are to design the valve gear. The piston is shown at one end of its stroke. but as yet there is no valve. The steam ports at *a* and *b* are ¾ inch wide and of ample area to allow the live steam to enter or the exhaust steam to escape from the cylinder. By reference to the theoretical indicator card, Fig. 3, we see that when the piston is just at the end of its stroke, as shown in Fig. 4, the valve should begin to admit steam at *a*, causing the pressure at *h* to rise to the steam chest pressure, as shown by the admission line H D of the card. If the pressure on the other side of the piston at *c* is lower than this, the piston will tend to move forward; the total pressure driving it being the product of this difference in pressure on the two sides of the piston, and the number of square inches in the face of the piston. This is square inches because we have used gauge pressure and the gauge reads pressure in pounds per square inch. If there were no opening at *b* the air or vapor in *c* would be compressed as the piston moved forward, and the back pressure would grow greater and greater until the pressure at *h* and *c* were equal, when the piston would

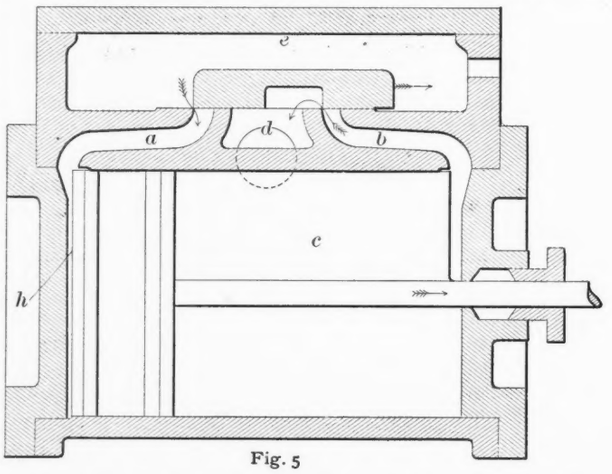


Fig. 5

come to rest. There is no such rise in the back pressure line H G in the theoretical card, and as everywhere the back pressure being H G is parallel to and but slightly above the atmospheric line A B, we have evidently assumed that the back pressure is small and constant. To secure this the space *c* must be connected with some passage leading to the atmosphere, and, as we made release F in the card occur just at the end of the stroke, we see that at the instant the valve admits steam at *a* it must also

open a passage to the exhaust at *b*. Now *a* and *b* both open into the steam chest *e*, and in the latter we cannot have at the same time both atmospheric pressure and a pressure approaching boiler pressure. However, by allowing the steam to flow past the outside of the valve at *a*, and by connecting *d* with the atmosphere and making a cavity in the under-side of the valve through which the exhaust steam may flow from *b* to *d*, we can secure the desired result, and Fig. 5 shows a valve which allows this to take place; the valve fitting closely to its seat so that no steam can leak in from the steam space *e* back of the valve, to the exhaust opening *d* underneath the valve.

If we now suppose the piston to move forward, as shown by the arrow, it is evident that the valve must move in the same direction in order that steam may be admitted from *e* to maintain the full pressure in the space *h* behind the piston. As the valve advances, the port openings for both steam and exhaust will now grow larger, and if this motion were to continue, both ports would be wide open when the piston reached the end of its stroke.

By reference to the card in Fig. 3 we find that we have assumed that cut-off E shall take place just at the end of the stroke, and reference to Fig. 4 shows that in order to allow cut-off to take place at all, the valve must come back to exactly the the same position that it occupied for admission, except that it must now be moving in the opposite direction. This is necessary because the same edge of the valve governs both the admission of steam and the cut-off. Fig. 6, then, shows the positions of the valve and piston at cut off; the latter has reached the end of its stroke while the valve is in exactly the same position as in Fig. 5; the arrow shows the direction of motion.

During the time in which the piston moved continuously from left to right from its position in Fig. 5 to that occupied by it in Fig. 6, or as we may say, while it moved along the same path, as from A to B in Fig. 7, the valve during one-half of this time must have moved toward the right from *a* to *b*, gradually opening the steam ports, and then during the other half it must have traveled toward the left from *b* toward *a*, gradually closing this port, the valve being at *a* when the piston is at A and back at *a* again when the piston reaches B.

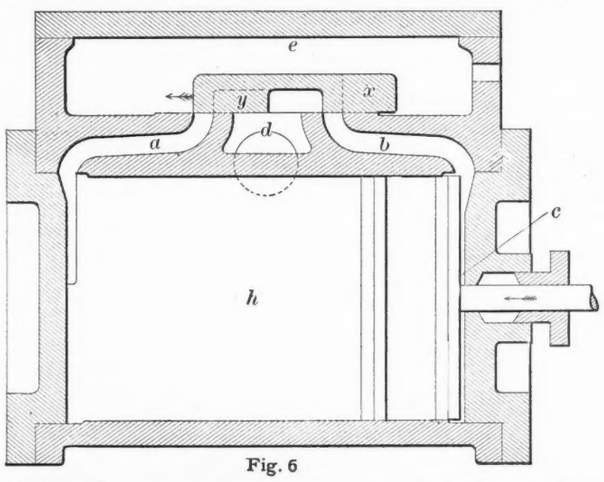


Fig. 6

The piston having come to rest, Fig. 6, at the end of the stroke and the valve being in the same position as in Fig. 5, we note that the passage under the valve, through which the exhaust steam has been escaping from *c* to *d* during the entire forward stroke of the piston, is now just closing, which fulfils the condition that we imposed when we drew the theoretical card (Fig. 4), exhaust closure H being just at the end of the stroke. The valve shown in Figs. 5 and 6 is therefore correctly designed if our engine is always to make its strokes towards the right. We desire, however, a double, not a single acting engine, and that the card produced during the forward stroke of the piston shall be duplicated on its return stroke. In order that this may be done, the valve in Fig. 6 should be just now beginning to admit steam through the passage *b* for the return stroke, and at the same instant the space *h*, which must now be full of high pressure steam, should be opening to the exhaust passage *d*. Noting the direction in which the valve is moving (as shown by the arrow in Fig. 6), we find that the self-evident way to make the engine double acting is to cut away the end of the valve at *x*, as shown by the dotted lines, which, as the valve moves towards the left, will admit steam from *e* to *b*, also to enlarge the cavity under the valve by cutting out a portion at *y* to allow the steam to escape from *h* through the passage *a* to the exhaust cavity *d* and thence to the atmosphere. Fig. 8 shows the completed valve, the piston being in the same position as in Fig. 6, just at the end of its forward stroke and ready to return to the position from which it started.

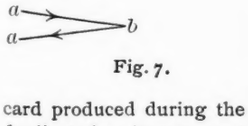


Fig. 7.

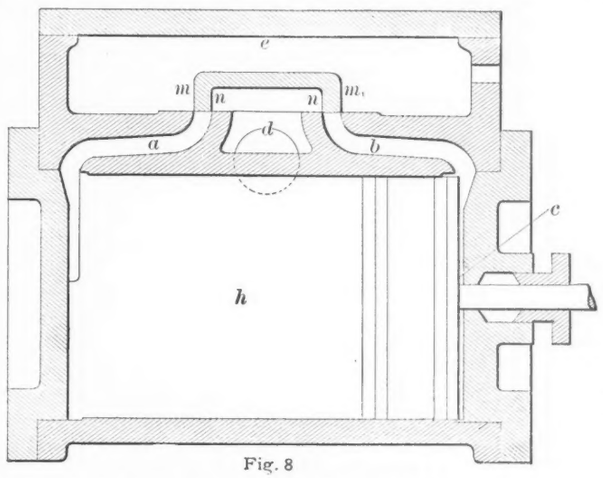


Fig. 8

We have termed the passages *a* and *b* *port passages;* the entrance to these passages which is opened by the valve is called the *port* (gate), the space *d* is called the *exhaust* cavity, the edge of the valve *m*, past which live steam flows to the cylinder, is called the *steam edge* of the valve, and the edge *n*, past which the exhaust steam escapes to the exhaust cavity, is called the *exhaust edge* of the valve; the surface (*s*, Fig. 4) on which the valve slides is called the *valve seat*, and the portion of the valve in contact with the surface is called the *face* of the valve, while the opposite side is spoken of as its *back*.

We now have a valve; the next step is to devise some mechanism that shall actually give it the motions which we have assumed it to have.

* * *

HERE AND THERE.

McKRELL TURNS UP.

Mr. Editor: McKrell has turned up and I feel rather happy over it. Makes us old chaps feel about twenty-five years younger to have a fellow we used to sleep with, and tramp with, and swap tools with, drop down years after we have reasoned that he must be dead—drop right down on us just the same old chum as ever. That's the way McKrell turned up; wanted to borrow a chaw of tobacco of some one before he had been in the shop five minutes.

Looking for a peg to hang his coat on, Mac said he was, and it didn't take long to find him one. Somehow there's always a peg or two left in about every machine shop in the land for just such coats as fellows like McKrell wear.

You see it was this way at Bildmake's. The Old Man had got me into more uneasiness than was comfortable all along, with his new automatic. Got a lot of them running and gets lots of grumbling about them.

The Old Man, in his kindly way of putting a thing, mildly insinuated that if I knew just a little about a steam engine I could go right around on a visit like to these engines and talk them into a condition of good behavior. "You can," said the Old Man, "make an engineer believe his engine runs all right and it will behave itself every time." Somehow I can't make this work. There's so many things about the Old Man's engine that I don't seem to know much about, that it seemed to me if I had Mac with me, what he knew and what I didn't know would make a rather big total.

It was a good deal like this with the Old Man. Got progress right on the brain, sure; got it real bad. Builds lots of engines, no mistake. Builds 'em and talks folks right into buying 'em, but

he couldn't build two alike, and he never knew just how he had built the second one back. Wasn't any progress in building two things alike; didn't make any difference whether the thing was a bicycle or a steam engine. Never seemed to think what a load of trouble you could pile up for the shop and its customers all along with progress, and go backwards all the time.

The Old Man's plan of building steam engines worked better so long as his trade was just local, but his machine work was good work and he spread out, got his engine's further from home, and things got more worrying like. Never had much opinion of a draftsman except as a necessary evil. "Why," said he, "if I want a valve pattern changed"—and he might have added, "I always do"—"I can take it right up to the pattern-maker and show him what I want done in just about a minute. Chalk doesn't cost half as much as ink, and it rubs out a good deal easier, and it isn't any more trouble to get a bigger crank-pin in, and some other things made larger or smaller, or longer or shorter; get these things done, I can, and no one in the shop knows anything about it. It takes just about a day and a half to get the best draftsman in the world to understand what I want, then he'll sit right down and argue about it till I get tired out, and give it up because I'm tired."

All this, it exactly seems to me sometimes, is the matter with the Old Man's planning things. Never knows whether Millen's engine had a 6-inch double-complicated back-action shaft, or a 7-inch straight go-ahead one; never knows himself, and there isn't anyone around that's got any particular business to know.

Gets an order for one of his 150 horse power engines, the Old Man does. Going 200 miles away into new territory, and wants it to run right. Orders the main valve and the cut-off valves into the pattern shop and sketches his visions of changes right out with a piece of chalk, all just as plain as the snout on a tea-kettle. "And see here," he says, just as he gets to the stairs, "don't forget to make the upper end of that rock-arm an inch longer, and piece out the boxes so as to drop the center two inches. Got to have more motion to that main valve somehow; plenty of room in the steam-chest and I'm going to use it." Then, to himself: "I must see the blacksmith and have the rods and stems forged larger, and let's see—well, now, I wonder how things would go here, anyhow, if there wasn't someone to look after this and that. Bet a five-cent cigar they'd bolt them rocker boxes up with three-quarter bolts, just because the drawing says so, if I wasn't around to order inch. Just keeps me busy all the time looking after these things that ought to be changed a little. Can't get time to sell an engine unless I do it nights or Sundays. Just takes my whole time to see that a customer gets the sort of engine he ought to have."

The 150 horse engine is a kind of favorite size with the Old Man. Got a good many of them scattered around and doing pretty well. Made a good many changes in the line of progress—changes in details—but he never got one to suit him just as this one was going to suit him.

This engine that I'm telling you about now was finished and went to work. Gave good satisfaction, but wasn't just right according to the Old Man's view of engines. Made three or four more changes and things went on for a year, then came a telegram from the owners of this one:

"Send valves and all connections for engine. No delay. Important."

The Old man was in a box, as the boys say, sure. Valves and connections been altered a half dozen times, more or less, didn't know which, since he began building 150 horse power engines. Didn't know when nor just how. Good customers; wanted to accommodate them if he didn't make more than two hundred and fifty dollars out of it. More trade that way. But Great Scott! what valves and fixings was he to send? Draftsman couldn't help him any, then the Old Man mildly asked him what in thunder he supposed he kept a draftsman for anyhow. Draftsman was rather certain he had never been able to study it out.

Well, sir, that draftsman had to take the next train over three or four country railroads, by the way of cross town connections, to find out just a little about what that customer wanted, to get things turning over again, the Old Man covering things blue all the time he was gone. Couldn't put a pattern in the sand till he got back.

You may say, Mr. Editor, that matters don't go that way now; used to once, but got over it. Seems to me they used to go that way once and go that way now a mighty sight more than we think about. That's the way they go with the Old Man, anyhow.

But I laid out to tell you something about McKrell. Used to work together, Mac and I did, way back in the '70's, for Older & Sons. "Sons" sort of rounded out the title, but Older was a good one, in his way. Never even saw an indicator, except in a museum one time, but he used to keep lots of steam engines tending to business around Steamkill, and McKrell was his best card. Finally, just about the time I hunted a job there, Mac bought an indicator and managed to get it hammered onto a good many engines round about. Didn't either of us know anything about an indicator, and Older used to just laugh about it, but somehow the more Mac swung it around the more he banked on Mac. Sort of hunted in pairs, Mac and I did.

One morning Older came into the shop and told Mac and I to go down to the Corners and fix Donner's engine up so folks could live in the same town with it. Donner's engine had been running only about a year and was just the pride of the Corners, especially of Donner. Wasn't one of them real live, high speed engines that didn't take any notice of centers, but 240 revolutions didn't let it loiter so long on any of the 480 dead points as folks round about were mostly used to.

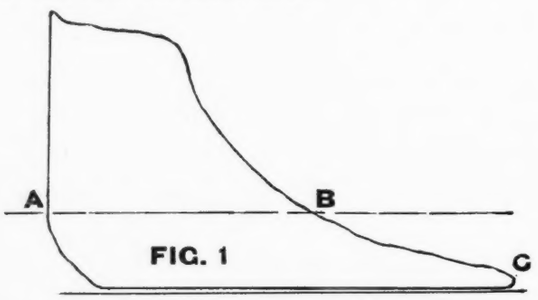


FIG. 1

Run as still as a clock that wouldn't tick, Donner's engine did, till about a week before he just doubled the load on her; work on and work off all the time. Heavens! how she pounded when everything was on. Didn't pound as if she had a steady job. Run as quiet as anybody's engine for an hour, more or less, generally less, then made it all up. I didn't know what the trouble was and it worried Mac. We got the indicator on when she was running on her good behavior, and got a diagram that looked a little like Fig. 1. Couldn't find any fault with it in particular.

"Wait till she pounds," said Mac.

Didn't have to wait long till she was doing some of her best thumps, and Mac got Fig. 2. Mac looked satisfied, but I didn't

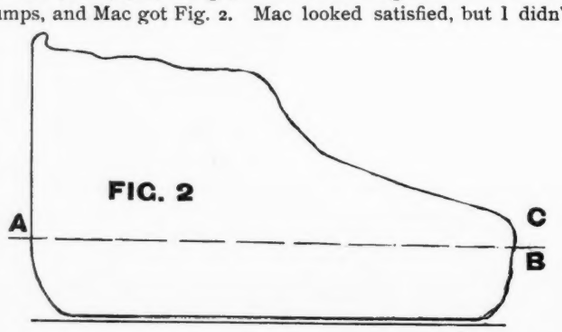


FIG. 2

see just where the trouble came in till he made it reasonable. He took his old dilapidated two-foot rule for a straight edge, borrowed my stub pencil and drew the line I have marked A B on Fig 1.

"Holds her steam pretty well down to the end of the stroke at C," (I'm putting letters in Mac's mouth.) "Compression bunches things up to A, then comes lead, but A is considerably higher than C. Lost motion and spring just nicely taken up and something to spare. Ought to run still. Now you just look at the other card (Fig. 2): compression doesn't get any higher than in Fig. 1; C is higher than A and she couldn't help pound. No other way to tell us things don't go right. Just think it over and you'll see all about it."

All plain when Mac had made it plain. Want to keep A higher than C to an extent depending mainly on the speed of the engine, but somewhat on the clearance, which has a good deal to do with the *time* in which the lost motion and general looseness is taken up.

"But what in blazes are we going to do about it, Mac?"

"Ought to have a new valve, that engine had, but that means

a new steam chest to give more room, a new eccentric to give more travel, and probably a new strap and a lot of other odds and ends. These are just about what I'd give it if it was my engine, and I had Donner's bank account; but if we were to talk to him about the probable cost of all this he'd think we'd set up a

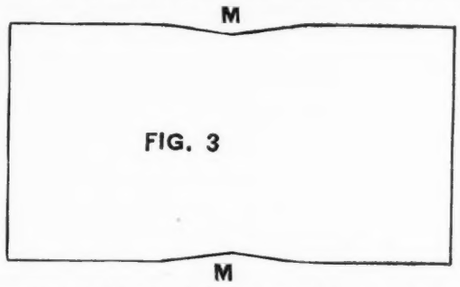


FIG. 3

conspiracy to rob him, and Older was aiding and abetting it. Tell you what we'll do, John, we'll just take that valve out and give it V lead, like this (Mac chalked out something which I interpret by Fig. 3); cut some V's like this (M), going easy, put her back in and try her, cutting wider and deeper if it seems the proper thing to do. Leave the old lead just as it is unless we get the V's too large. If we do this we'll take off a little lead. Got a way of recompense, you see. Seems as though this might bring A up higher—bring it up slowly like. Don't like that way of doing it, but they say it's better than no way."

Mac and I worked away at that valve (cut and try) till finally

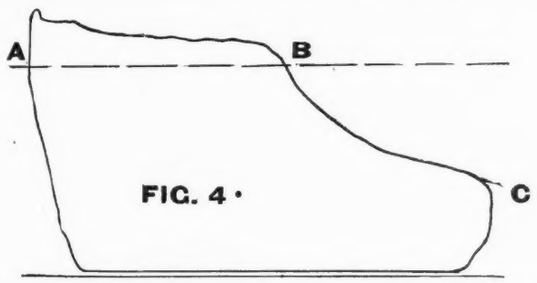


FIG. 4.

we got a diagram more like Fig. 4—got that kind of a diagram and got rid of the pounding pretty much.

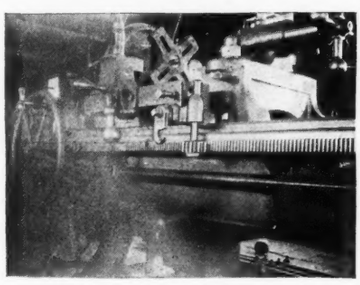
You see, Mr. Editor, Mac has got more of these little tricks than I have ever cornered, and that's why I was glad he had turned up to help me with the Old Man's only one of the kind.

Regardant, JOHN LOOKABACK.

* * *

VERTICAL RACK ON LATHE.

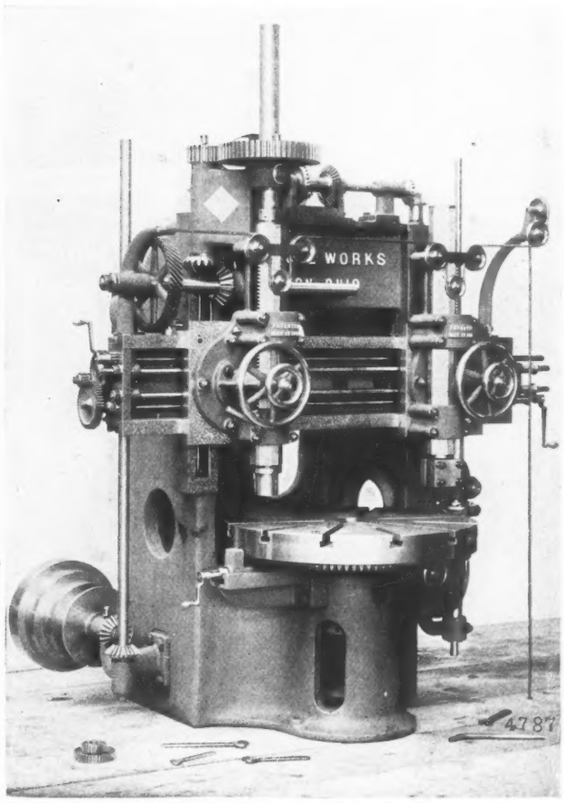
Some of the old lathes with a pretense of a lathe carriage had racks fastened to the side of bed, with the teeth pointing heavenward, a design which makes an excellent dirt and chip catcher, but which has little else to recommend it. This has in most cases given way to a rack placed up under the "eaves," so to speak, of the lathe bed, the teeth projecting downward, out of the way of the dirt and in apparently the best position possible. Having been accustomed to the two positions and these only, the one shown herewith was something of a novelty. The rack is placed vertically, teeth pointing out, of course, and apparently serving its purpose nicely, although the modern method is preferable in every way.


LATHE WITH VERTICAL RACK.

* * *

BORING AND TURNING MILL.

This is the 37-inch boring and turning mill of the Niles Tool Works, Hamilton, Ohio, and shows the machine with one standard head and one independent boring head. This arrangement of heads is especially adaptable to work that requires boring or drilling and which cannot be done with the standard head; such, for instance, as the holes in eccentrics and similar work. The standard head is arranged so that it will swivel, and can be used for turning and boring tapered as well as straight work. The independent head is driven from a separate countershaft and cone which transmits motion to the vertical shaft shown on the left-hand side of the machine, and from there to the pinion which meshes into the large gear on the boring spindle that passes through the bar of the left-hand head of the mill. It will be noted that the head is adjustable on the rail, so that it can be used on work from the center of the table up to a diameter equivalent to the full swing of the machine. This independent boring bar is adjustable for wear, is counterweighted and is arranged with power feed, the same as the standard head. The clamping device is arranged, as shown on the left-hand side of the table, so that the table can be held in position when the independent boring is being done. This head can also be used for turning and facing, the same as the standard head. It will be seen that a large amount of work that requires separate boring, can be accomplished on this machine with this special independent boring head, by one clamping of the work. All the good features that are incorporated in the standard boring and turning mills of this company are retained in this machine, but special attention is called to the independent boring head, which makes the machine peculiarly adapted to a wide range of work that has heretofore required two settings on two different machines, but which can be done on this tool with one setting of the work, thereby materially reducing the cost of the product.



NEW NILES BORING AND TURNING MILL.

* * *

NEW SHOPS OF THE BAUSH & HARRIS MACHINE TOOL CO.

This company is now moving into new and up-to-date shops, which has just been completed by them at Springfield, Mass. The general arrangement is so good and contains so many practical ideas, that we give herewith quite full details thereof.

As will be seen by referring to the general plan, the plant is so arranged as to facilitate as much as possible the continuous progression of work, from the foundry through machine departments to erecting room and shipping end of shop; *i. e.* where the railroad enters at the end of the erecting department.

The heavier tools are necessarily placed in the erecting depart-

ment to allow of service by traveling crane, while the smaller tools such as make up the usual up-to-date machine shop, are located in the machine shop proper.

Beginning with the foundry, there is a commodious brick building with iron trussed monitor roof 205 feet long by 50 feet wide and 24 feet high in the clear. The stock-room and core-room with ovens, are adjoining the main building and an electric traveling crane serves the entire length and width of the latter. The shop is also equipped with a narrow gauge track, which runs the full length. This railway is conveniently adapted for handling flasks in the foundry and for transferring castings into and through the machine shops. An hydraulic elevator conveys iron and fuel to the charging floor and the blower for stacks is driven by an electric motor, which also serves to operate the tumbling barrels and sand mixers.

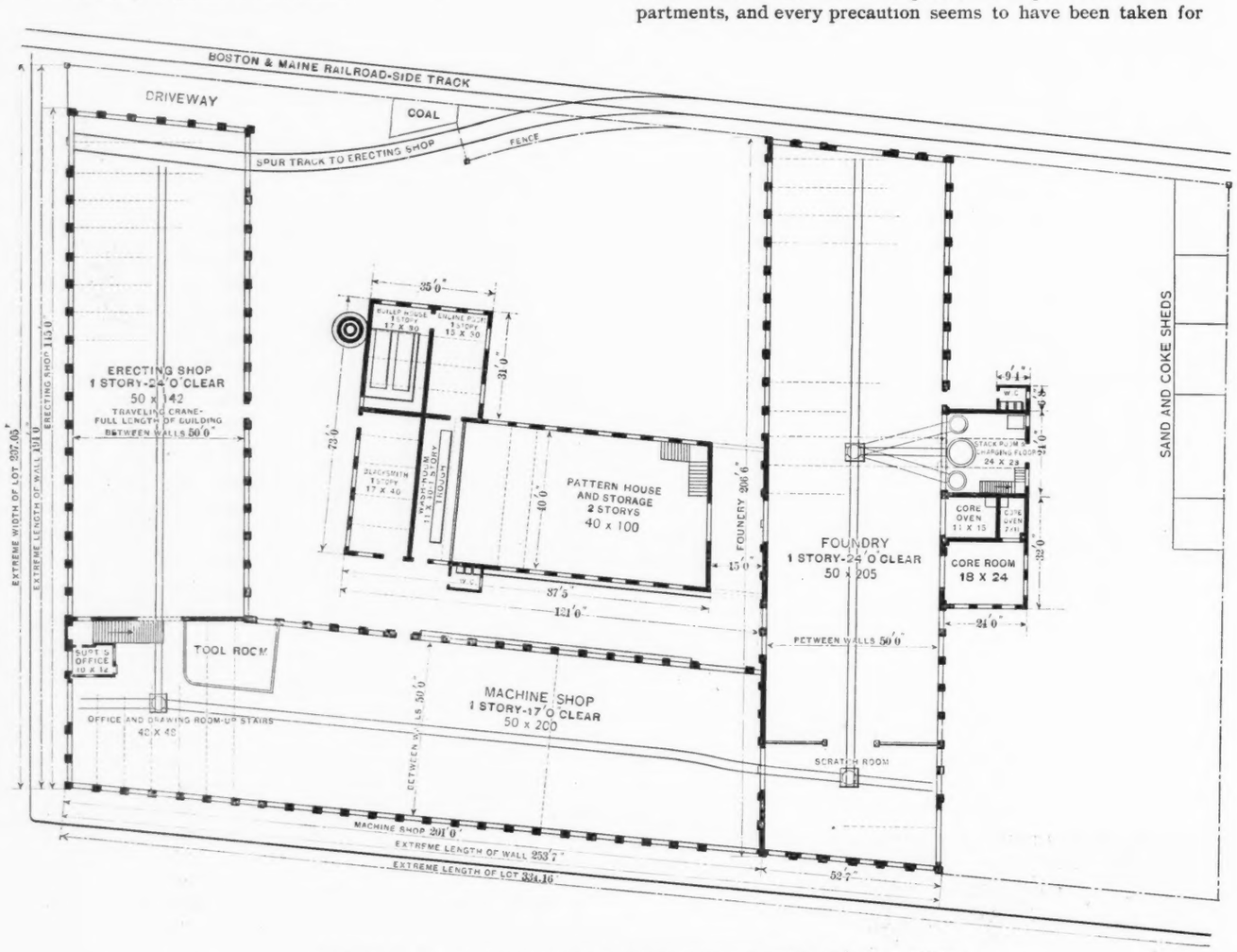
The usual sand, coke, and clay sheds are built at the rear of the foundry, adjacent to the tracks.

supplied with a ten ton Shaw Electric Traveling Crane.

THE PATTERN STORAGE HOUSE

and pattern making shop, are located in a suitable two story brick building, which is conveniently connected to the foundry and machine shop. Adjoining this building are the engine room, boiler room and blacksmith's shop. (One 175 HP. boiler is used in place of the two smaller boilers, as shown on plans).

The engine is a Slater, 150 HP., of their latest design. The boiler is of the usual horizontal tubular type. The plant includes a large electric generator for supplying a complete lighting and power system. Driven wells supply an abundance of excellent water for all purposes. The water piping is so arranged as to allow of using water from the city mains (which have a pressure of from 90 to 95 pounds) direct to the boilers, while using well water elsewhere, or to use city water altogether if necessary; in other words, the system is interchangeable and insures water under all circumstances. Generous fire protection is provided in all departments, and every precaution seems to have been taken for



GENERAL PLAN OF WORKS—BAUSH & HARRIS MACHINE TOOL CO.'S NEW SHOPS.

THE MACHINE SHOP.

This building extends from the east end of the foundry and is 200 feet long, 50 feet wide and 17 feet in the clear, built of brick with iron trussed roof. No traveling crane is used in this shop; air hoists and light wall cranes are substituted. Herein are located the general machine tools and appliances.

At the end of the machine shop is located the superintendent's office, and above, at this end the building, which is carried up two stories, the offices of the company, which include a large waiting room, counting room, private offices and engineering department.

THE ERECTING SHOP

continues on at right angles from end of machine shop, running parallel with the foundry, connecting with the railroad. In this shop are placed the heavy tools and, as the name implies, it is used as an erecting room. This building like the others is of brick, 143 feet long, 50 feet wide and 24 feet high in the clear. It is

safety in this direction.

In the transmission of power, shafting is employed to all departments except the foundry. Suitable clutches are conveniently interposed in line shafts for cutting out different sections in case of accident or otherwise. Wood pulleys are used throughout and all line shafting is supported on brackets from the wall.

The lighting is by arc and incandescent systems and supplies all departments. No gas is used except in boiler room and in offices, when in use after power is shut down.

The heating system was installed by the B. F. Sturtevant Co., and is a model of perfection. A separate engine drives this apparatus which is placed on the lower floor of the pattern storage building, next to the wash-room.

The buildings in the main are one story high, with extra large windows; all roofs are supported by iron trusses, and the entire arrangement is admirable and modern in every particular. This is best seen by a bird's-eye view of the plant, which we regret being unable to make room for.

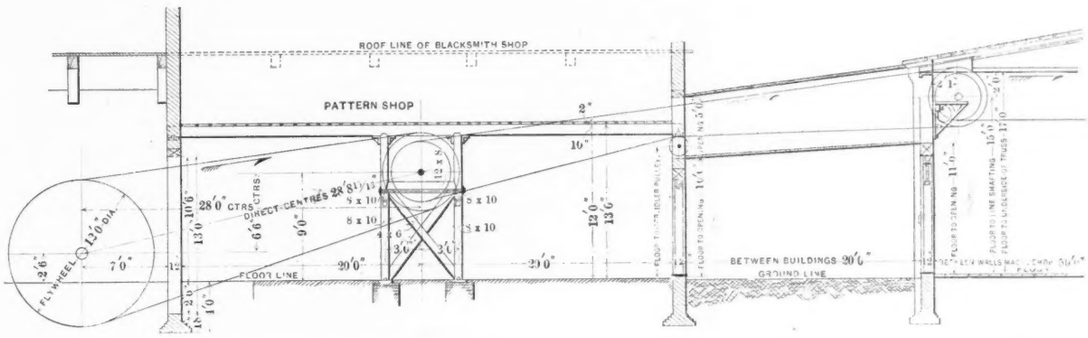
A spur track from the Boston & Maine Railroad enters the yard and shop, and allows of shipments direct from floor to cars.

Besides their regular machine tool business, which includes the well known Baush radial drills, horizontal and vertical multiple drills, boring machines, milling machines, lathes, splining machines and specialties, the company do an extensive foundry business, making castings of all descriptions and sizes. Still another department, devoted to structural iron work, employs a large force of men and is of increasing importance, as iron enters more and more into modern building work.

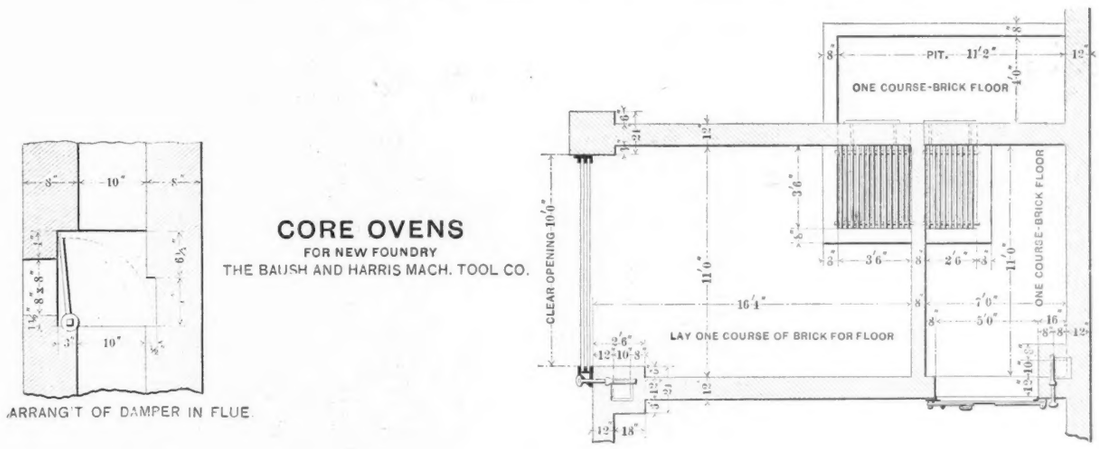
* * *

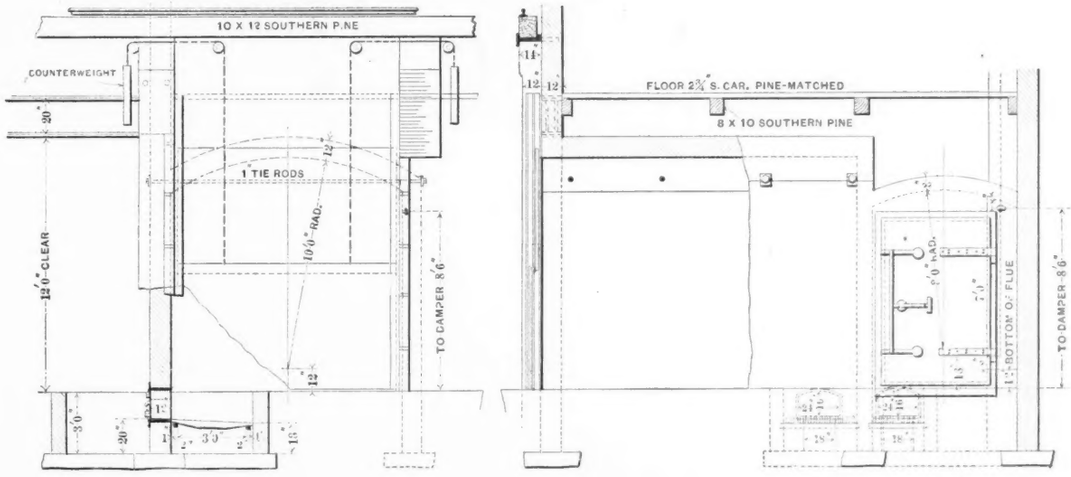
BELTS.

It is stated on the authority of the *Centralblatt fur die Textil Industrie* that belts which are dirty from drop oil and dust should first be washed with warm water and soap, using a sharp, stiff brush, and while still moist to rub them with a solution of sal ammoniac, which saponifies the oil in them. Immediately thereafter the belts must be rinsed well with lukewarm water, and then dried with sufficient tension. While they are still moist the belts are to be rubbed well on the inside, and less on the outside, with the following: 2 lbs. ¾ oz. of india rubber heated to 122 deg. Fahr., and mixed with 2 lbs. ¾ oz. of rectified turpentine oil. After the solution is complete, 27 oz. of bright resin are added; and when it is dissolved 26½ oz. of yellow wax are added. This mixture, by diligent stirring, is mixed with 6 lbs. 10 oz. of fish oil and 2 lbs. 12 oz. of tallow, previously dissolved in the former. In the further treatment of the belt, rub the inside only and the outside only the first time as stated. The unguent also replaces the tannin extracted from the leather, prevents the dragging of the belt, and imparts elasticity to it.



MAIN POWER TRANSMISSION—BAUSH & HARRIS MACHINE TOOL CO 'S NEW SHOPS.





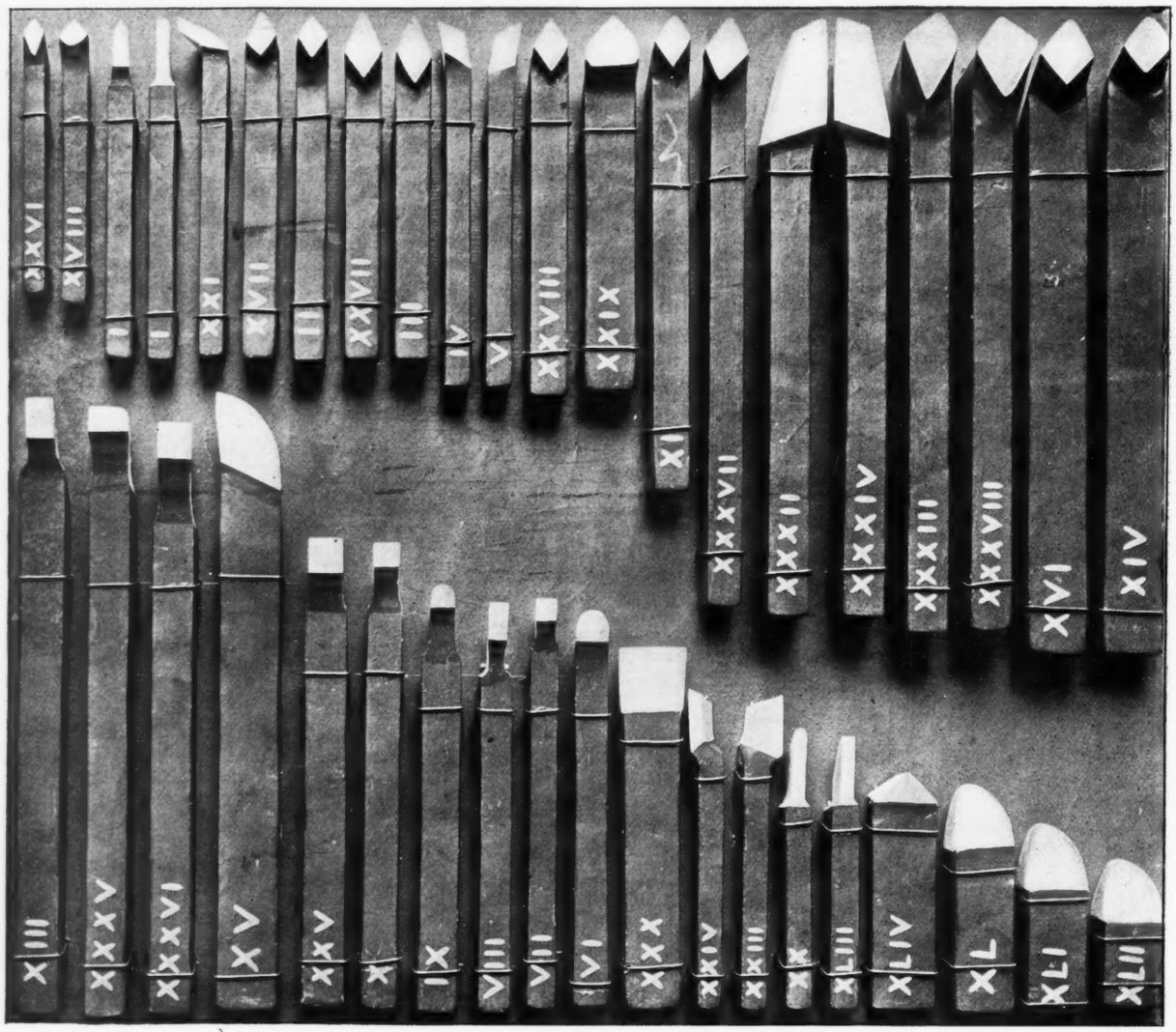
MR. R. GRIMSHAW has taken a rather novel course to advertise his books on Pumps, Boilers and Indicators. He proposes to issue a series of silver and bronze medals to engineers in the principal cities of the United States, who stand the best examinations on pumps, boilers and indicator practice, his books to be taken as the text books, and whose engines shall be judged to be in best condition after being in their charge one year; engine to be not less than five years old and at least 100 HP. New York medals to be awarded by the James Watt Association, N. A. S. E.; Philadelphia medals by Franklin Institute.

CAST IRON TURNING TOOLS.

Although a good many have probably heard of lathe tools of chilled cast iron, comparatively few have ever seen or used them, and the accompanying engraving of the tools used at the Altoona shops of the Pennsylvania R. R. (which was kindly loaned us by the *American Engineer, Car Builder and Railroad Journal*), will be of interest. These are used for turning, boring and are cast in exactly the right form required, and being made from a pattern, are uniform in shape and size.

The various kinds which are made and used are shown herewith, and the list of sizes will indicate the uses in which they are employed.

The men are said to prefer them to steel tools, and as they generally work by the piece, it is pretty safe to assume that they can do more work with them than with steel.



LIST OF CAST IRON TOOLS.

		Inches.
I.	Round nose for iron and brass	1⅜ x ⅝ x 8⅜
I.	Thread tool for wrought and cast iron	1⅜ x ⅝ x 8⅜
II.	Diamond point "right hand" "lathe"	1⅜ x ¾ x 8½
III.	" " " "	1⅛ x ⅞ x 8½
IV.	Diamond point side tool, "right hand" "lathe"	1⅜ x ⅝ x 9
V.	" " " " " "	1¼ x ⅝ x 9
VI.	Round nose for lathe or planer	1½ x 1⅛ x 9¾
VII.	Square " " planer	1¼ x 1⅛ x 10¼
VIII.	" " " lathe	1⅜ x ¾ x 10
IX.	Round " " " or planer	1 x 1 7/16 x 10⅝
X.	Square " " "	⅞ x 1½ x 11½
XI.	Diamond point for lathe or planer	1½ x 1 x 13¾
XIII.	Square nose for lathe or planer	2 x 1½ x 15
XIV.	Diamond point for lathe or planer	1½ x 1½ x 15⅝
XV.	Oyster knife for planer	1½ x 1½ x 15¼
XVI.	Diamond point for planer or lathe	1½ x 1½ x 15½
XVII.	Diamond point for planer, "left hand"	1½ x ⅞ x 8½
XVIII.	Diamond point for lathe	1⅝ x ⅝ x 7
XX.	Round nose for lathe	⅝ x 1 x 7
XXI.	Boring tool for lathe	1 1/16 x ⅝ x 8⅜
XXIII.	Left hand side or facing tool for lathe	1½ x ⅝ x 8
XXIV.	Right hand side or facing tool for lathe	1½ x ⅝ x 8
XXV.	Square nose for planer	1 1/16 x 1½ x 11½
XXVI.	Diamond point for lathe	1½ x ½ x 6¾
XXVII.	" " " " or planer	⅞ x 1½ x 8½
XXVIII.	" " " planing and facing cylinders	⅛ x 1⅜ x 9⅜
XXIX.	" " " planer or facing mill	1¼ x 1¼ x 9⅛
XXX.	Square nose for turning cylinder flanges	1⅜ x 1⅜ x 9
XXXII.	Side tool for axle lathe or planer	2 x 1 x 14½
XXXIII.	Diamond point for axle lathe or planer	2 x 1 x 15
XXXIV.	Side tool for axle lathe or planer	2 x 1 x 14⅝
XXXV.	Square nose for axle lathe or planer	2 x 1 x 15
XXXVI.	" " " " " " "	2 x 1 x 14½
XXXVII.	Diamond point for planer	1½ x ⅞ x 14½
XXXVIII.	" " " axle lathe	2 x 1 x 15
XL.	Tools for boring cylinders (Baldwin)	1½ x 1½ x 5¾
XLI.	" " " " "	1½ x 1½ x 4¾
XLII.	" " " " "	1½ x 1½ x 3⅝
XLIII.	Square nose for lathe	1¼ x ¾ x 6¼
XLIV.	Boring tools for driving boxes	1⅝ x 1 1/16 x 6

CHILLED CAST IRON LATHE OR PLANER TOOLS USED IN THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

planing both wrought and cast iron and brass. It is found that that they will not stand the service of cutting steel, as the cast iron has not sufficient strength to resist the strain, and the cutting edges of the tools crumble in doing that kind of work.

These tools are cast from the ordinary iron used for making chilled wheels, the point or cutting end being chilled, and then ground in the usual way. It is said that they stand equally as well or better than steel tools do, and are very much cheaper, and

THE J. A. FAY & EAGAN CO., Cincinnati, Ohio, write us :

"All connection between ourselves and Chas. A. Gilbert, formerly one of our salesmen located at Atlanta, Ga., has been severed. Mr. Gilbert has not nor never had authority to make collections for our account. No drafts or other demands made by him will be honored. Mr. Eugene Donelly, formerly with our New Orleans office, been placed in charge of our Atlanta office, No. 36 West Alabama street."

MY BACKWOODS PROFESSOR.—1.

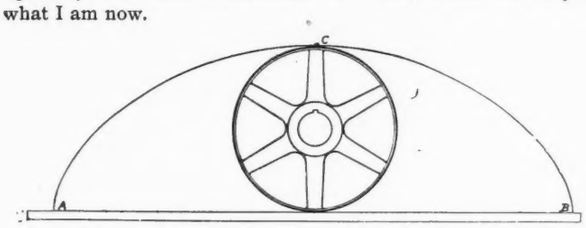
JONATHAN JONES, JR.

Some men seem to have a dread of such names as philosophy, algebra, geometry, trigonometry and a few others, and judging from most books on the subject I don't blame 'em any, for to tell the truth I'm almost afraid to look into one of the text books myself, if anyone is around to ask questions which perhaps I couldn't answer. But there's a good many of the things that seem hard and puzzling to a fellow without much education that can be made somewhat clearer than Schuylkill water after a rain, if the instructor knows how to make things plain enough for his students, and some require them mighty plain, too. I was one of that kind. In fact I was and am skeptical on most subjects, although an old professor who examined my head—for bumps—smoothed it down a little by saying I merely required proof, instead of taking things for granted. At any rate I did need proof, and by the way, any teacher that can't tell a fellow *why* a thing is so isn't the man for the place.

But my teacher wasn't a professor—guess he'd smile to be called one, for on some things I could give him points and come out ahead; but when it came to cold-blooded reasoning things out, putting two and two together, as it were, he was a hard man to beat. He seemed to anticipate your questions—guess he must have been a hard learner, too, and you didn't have to do much but listen when you got him explaining anything. Who was he? Well, it wasn't in any college, or even trade school, but in my father's old shop, and the teacher was his hired handy man of the place.

I was a youngster—just fifteen—and "learning my trade" in the old shop, and as the rules were not very strict we had plenty of time for lessons, arguments and such things, almost as much as we did for work. One of the first questions we discussed was the old problem of whether the top of a wheel went faster than the bottom or not. I maintained it didn't—said 'twould twist the wheel out of shape and go chasing itself around the axle. But Josiah (his full name was Josiah Peppercorn) insisted it did travel faster, with regard to the ground, but not with regard to the axle; that was what kept it in shape, to use my expression.

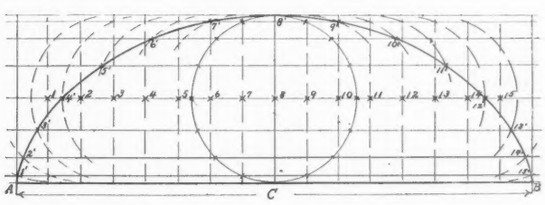
"The best way to answer those questions, Jonathan is to show you in black and white, or better yet, in actual wood and iron; paper is good enough to explain with when you can't use iron; but the real article is the thing." And I believe he is right, 'specially with such a blockhead as I was, which isn't saying what I am now.



"Now here is a ten-inch pulley, and we'll just nail this strip of wood on the edge of the bench to make it easier measuring." And he nailed a strip, like A in the figure, so it projected about an inch above the bench, Then placing the pulley at the left he said: "Now, we'll tie a piece of chalk to the inside of the rim—by rights it ought to be just at the outside edge, but the rim is so thin it will do for our chalk experiment, then starting at the point B we'll roll it toward the right and see what kind of a line it draws; there," as it finished its course and the chalk came back to the board, "you see the curved line it made? Well that shows the part of the rim where the chalk was, traveled the whole length of the curved line, while the bottom just rolled along the board from B to C. Now let's measure this distance which we call B C—$31\frac{7}{16}$ inches, almost. If we measure exact, it would be 31.416 inches. Why? Because careful measurement shows the circumference is 3.1416 times the diameter; $3\frac{1}{7}$ is common practice for us backwoodsers, but you may go to the city some day, Jonathan, and you better remember this.

"Now we'll measure the curved line; take this steel tape line and lay it carefully along the line; now let's see—nearly 40 inches; would be just 40 if we'd measured carefully and had drawn the curve just at the edge of the rim. I s'pose you wonder how I know this. Well, I first learned it from my old Haswell," and he pulled out a worn copy of the well known book; "and then I've proved it often. The curved line formed in this way will be just four times the diameter of the rolling circle or pulley. The curve drawn in this way is called a *cycloid*, and has several peculiar features. It is used for forming the upper part of the teeth of racks, and of gears, only in the latter case the circle is rolled around another circle (the size of the gear wheel); but we'll leave that for some other time. Now you take your note-book and put down under the head of "Cycloid," and make a rough sketch of the curve, the board or base line and the pulley—just a circle will do; then call the starting point A, the ending place B, top of curve C, and the diameter of circle D. Then say: A B = D × 3.1416. Curve A C B = D × 4. Area of cycloid (surface between curved and straight line A B C and A B)= Area of circle × 3. When drawing gear teeth we don't use a pulley to roll around, because we don't often have one just the size we want, but we lay it out on paper, or a board, or any smooth surface.

Let's take this sheet of tin, my old dividers, a scale or rule, and a scriber, which is all we need to draw a cycloid, or same curve as the chalk made, without a pulley. Now we draw our line which corresponds to the board on the bench. Taking 2 inches in our dividers (which will draw a 4 inch circle) we draw one in the center of the line (as shown below) and mark the point where it rests as A C. Now we multiply 4 by 3.1416 and get 12.5664, or about $12\frac{9}{16}$, and measure it off to B, or if we use $3\frac{1}{7}$ as the multiplier we have $12\frac{4}{7}$, which equals 12.57 instead of 12.5664—pretty close for rough work, but decimals are pretty good things to use. Now divide A B into any number of equal parts, the more the better for accurate work, sixteen will do for this, and number them like this:



"Taking my triangle and placing base on line A B we'll draw vertical lines up from each point, and then divide the circle into as many parts as the base, beginning to stop them off at C. Through these points on the circle draw horizontal lines as shown. Then with the dividers set to the radius of the circle, we place one point on 1 and mark through the horizontal line nearest the base line A B, as at 1'. Repeating this with each point 2, 3, 4, etc., we get 2', 3', 4', etc., and through all these points draw a free curved line, which you see, Jonathan, will give the same curve as the other. I've learned that by heart and spin it off like a parrot, but it's about the easiest way I have found, although there are several others. We'll talk about this in laying out gears when we have another chance, and see if you can remember this over night."

I believe I could have learned calculus if I had been given such a teacher. As it is—well, I haven't, that's all, and don't know whether I ever shall be able to or not.

* * *

A WONDERFUL BICYCLE.

ONE of the amusing sides of the reports of mechanical inventions published in daily papers, was recently seen in the Philadelphia *Times*. The victim of the reporter in this case was an alleged new chainless bicycle which, according to the article, must be fearfully and wonderfully made. Among other startling features is a *ball bearing belt*, which enables the machine to be controlled or even stopped by back pedaling. A wheel which has such marked improvements as these is sure to be in demand (?).

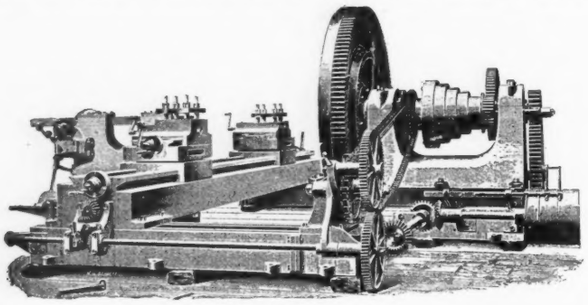
* * *

MR. WILLIAM C. REDFIELD, treasurer of J. H. Williams & Co., manufacturers of drop forgings, Brooklyn, N. Y., has announced his candidacy for Congress in the Second Congressional District, on the National Democratic ticket. As a thorough business man he would be in striking contrast with some of the members who (dis)grace the lower house—or the upper house either.

ITEMS OF MECHANICAL INTEREST.

SURFACING AND BORING LATHE.

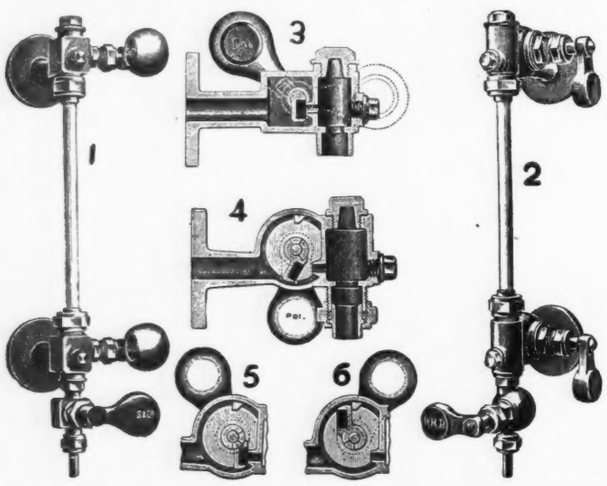
We illustrate herewith a large surfacing and boring lathe recently constructed by Messrs. Shepherd, Hill & Co., Ltd., of Leeds, for Mr. T. Smith, of Rodley. The machine in question is arranged to simultaneously turn and bore castings up to 18 feet in diameter and 5 feet deep. The machine has been built with a double and treble gear to headstock, with 42 inch centers, and carrying a large face-plate, which is fitted at the back with both external and internal wheels. The cross-slide carrying the tool-post saddles is 21 feet long, and very strong and deep. To secure still further rigidity, the center of this cross-slide is supported from the bottom of the pit by an arrangement not shown



in the illustration. The compound slide-rests which ride on this cross-slide can be fed either automatically or by hand, for both parallel and taper work. A feed of as much as ¼ inch per revolution can be obtained from the "self-acts" when required. The boring head is lipped in and securely bolted to the cross-slide, and travels with it when opening or closing the gap. It carries a 5-inch square steel sliding spindle operated either by hand or self-acting feed and has a quick-return motion arrangement for speedily withdrawing the tool. The cross-slide is traversed on its beds by power, and can be moved at the rate of 6 feet per minute. The complete machine weighs 40 tons, and when erected was bolted down to heavy foundation beds.—*Engineering, London.*

NEW FEATURE IN GAUGE-GLASSES.

A boiler room can be made very lively by the breaking of a glass water-gauge tube, where there is no automatic device for shutting off the steam and boiling water when such a breakage occurs. There are too few such safety gauges in use, and fewer yet that may also be readily shut off at will, for the purpose of cleaning or renewing the tube. The fitting shown here, and which

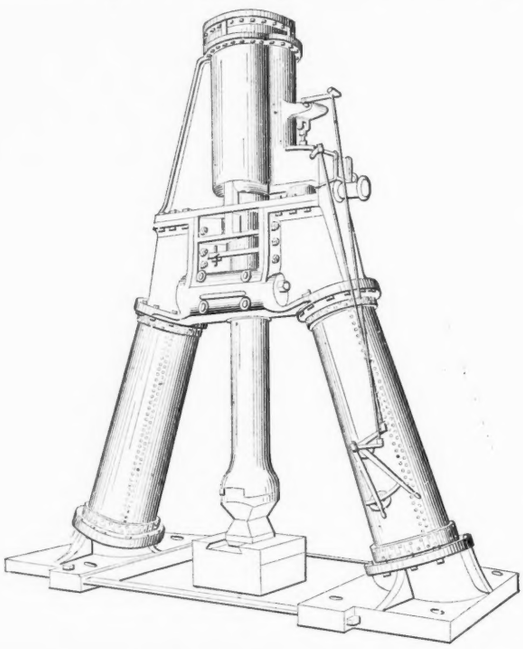


is in use in many important German establishments, has the two desirable features just referred to, and in addition to this, there is absolutely no need of a separate shut-off cock for tube renewal. Fig. 1 shows the device as fitted without automatic closing arrangement, Fig. 2 illustrates the automatic form. (For purely commercial reasons the first has four-sided mountings and the second cylindrical). As may be seen in Figs. 3 and 4, the glass is simply slid in from above by the removal of the upper plug; the valve or shut-off being held against the seat by the weighted lever, when the latter is as shown by full lines in Fig. 3. The valve is packed with "Schumanit," which retains its elasticity under full steam pressure and temperature.

In Fig. 3 the valve is fast on the spindle; in Fig. 4 loose. In Fig. 3, after the glass is put in the handle is brought into the position shown by the dotted lines, and the opening is then free. In Fig. 4 the handle normally, when the boiler is in service, hangs vertically, and the valve keeps the position shown in Fig. 6, leaving full opening. Should the glass break, the valve is pressed against its seat and the opening thus closed. While this should be safe enough, the fireman may "make assurance doubly sure" by throwing the handle forward. To put the gauge in service again, the valve is brought into the position shown in Fig. 5, and the handle thrown back. R. G.

OPEN FRAME STEAM HAMMER.

The accompanying engraving shows quite a departure from usual practice in steam hammer design, the usual cast iron frame being replaced by one built up of plate steel, rolled and riveted into circular shape and slightly larger at the base than at the top.



It is a 12-ton hammer, built by Bement, Miles & Co., Philadelphia, Pa., for the Facer Solid Steel Car Wheel Co., L'td, Perth, Ont., for forging steel car wheels from solid stock.

The steam cylinder is 38 inches in diameter with a stroke of 6 feet 6 inches. The piston-rod is of steel, 21 inches in diameter, and has a bearing both at lower end of cylinder and at bottom of the upper casting. The hammer is double acting, the valve gear operated by hand and the valve is said to be perfectly balanced. The base plates are tied together by two heavy bars, which are keyed in position.

* * *

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

12. A. R. T. writes: What is meant by cast iron turning tools? One of the new men in the shop spoke of them the other day and we don't know whether he is trying to play a joke on us or not. *A.* On page 94 you will find an illustration and brief description of some of these tools, which are not in as extensive use as their merit would seem to warrant.

13. A. H. asks: 1. Suppose a compound condensing engine to be suddenly overloaded to such on extent that both cylinders take steam full stroke, and the speed is thereby reduced; will the engine stop? *A.* We suppose you mean to ask if the overloading will stop the engine; to which it may be said, not necessarily. The overloading may simply result in reducing the speed or in stopping the engine according to its extent. If you mean to ask if the fact that the governor, by its legitimate action, has provided

for full stroke steam to each cylinder, will stop the engine, the answer is, no. 2. Will the admission of live steam to the receiver, at boiler pressure, help matters: that is, will it restore the engine to its normal speed? *A.* This would operate in the direction of keeping up speed, but it would be poor economy to provide for operating an engine in this way.

14. H. F. C. asks what we really think of the wide belt question, as treated by Mr. W. L. Cheney, in the September issue. *A.* It is better not to rely on anyone's opinion when you can test it yourself in the shop. Put a pulley with, say a 4-inch face, in the vise and take a piece of belt about 3 inches wide and long enough to go over the pulley and hang down a foot on each side. Hang a weight on one end and put a spring balance on the other. This can be done by driving a belt punch through the belt at each end; this affords a place to hang weights and to hook in the spring balance. Pull steadily until the belt moves on the pulley and note the amount on the spring balance when it is just moving steadily. Repeat this till you are sure of the result. Then split the belt lengthwise into say three strips, and repeat the operation with one of these strips, using the same weight as before. This will give you the comparative adhesion or friction between the belt and the pulley for the different widths with the same total tension. Make tests enough to satisfy yourself and you will then have the satisfaction of knowing the result without taking anyone's word for it.

15. L. B. R. wants a rule for calculating the weight to be put on a safety valve lever when weight of lever, weight of valve and stem, and length of lever is known. *A.* For a thorough calculation of safety valves, we will refer you to the article by Wm. Cox, on page 368 of the August issue. The formulæ given in Kent's Pocket Book is handy and is given below:

W = weight of ball at end of lever in pounds.
w = weight of lever in pounds.
V = weight of valve and spindle.
L = distance between fulcrum and center of ball.
l = distance between fulcrum and center of valve.
g = distance between fulcrum and center of gravity of the lever.
A = area of valve in square inches.
P = steam pressure to open valve.

$$\text{Then } P \times A \times l = W \times L + w \times g + V \times l.$$

$$P = \frac{W L + w g + V l}{A l} \quad (1).$$

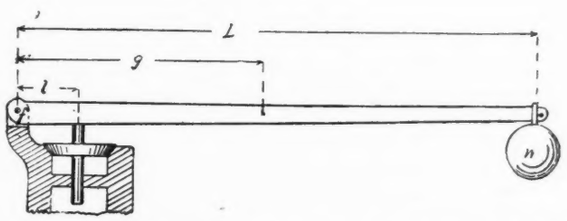
$$W = \frac{P A l - w g - V l}{L} \quad (2).$$

$$L = \frac{P A l - w g - V l}{W} \quad (3).$$

Assume steam pressure to blow off 100 pounds, a valve 3 inches in diameter (or 7.0686 square inches area), weight of valve and spindle 3 pounds, length of lever 30 inches, weight of lever 5 pounds, distance from fulcrum to center of valve 4 inches, distance from fulcrum to center of gravity of lever, 12 inches. To find this last distance, balance lever over a knife edge, and note distance from fulcrum to knife edge, this being practically the center of gravity. Taking formula 2 we have

$$W = \frac{100 \times 7.0686 \times 4 - 5 \times 12 - 3 \times 4}{30} = \frac{2827.44 - 60 - 12}{30} =$$

$$\frac{2755.44}{30} = 91.846 \text{ pounds.}$$



With the aid of the sketch it will be easy to see how this applied and why the different operations are performed, f is the fulcrum. The other formula allows either the blowing off pressure or the length of lever to be obtained, when the other factors are known.

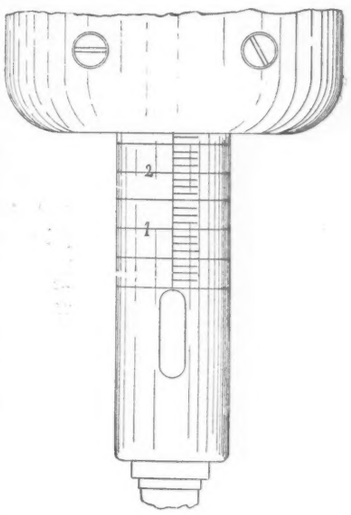
WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

GRADUATED DRILL PRESS SPINDLE.

One of the apprentices in the Fallbrook shops has graduated his drill press spindle as shown in sketch. By noting what graduation is just appearing when starting a hole he is enabled at any time to tell the exact depth drilled. This may be old, but it would seem that drill press manufacturers generally could adopt it to advantage.

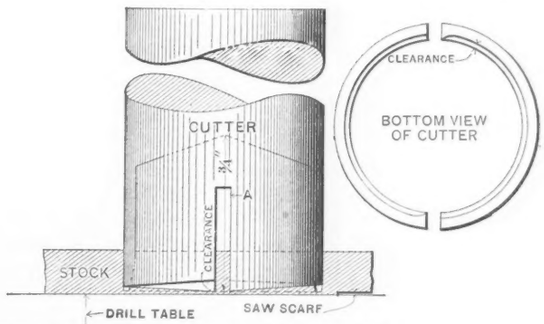


This shows that the boy is a wide-awake chap, and does a little thinking as well as working, and though he probably will not get any more money out of it at present, he is developing his ideas and will some day have a chance to better himself both financially and otherwise. It pays to take an interest in little things, even if we don't see any immediate result.

Corning, N. Y. FRED E. ROGERS.

FROM ACTUAL PRACTICE—PLUG CUTTER.

Noticing the dowel pin cutter in your April number, reminds me of another labor saver, the plug cutter. In making finished wood work of many kinds it is often necessary to plug holes so that the side grain of the plug will show instead of the end.



In a shop visited recently, one of the men in doing a piece of work, required 1800 such plugs. To turn them either straight or tapering by the old method in a lathe, would have taken about three days and a half (turner's own estimate). Instead of having them turned, he went and bought a piece of steel, paying 16 cents for it. Then he got the machinist to drill a ½ inch hole in one end about ¾ of an inch deep, and turn it true on the outside. With a file he enlarged the end of the hole a little, so that the plugs would be a little tapering, and split it open on two sides far enough back to leave an opening at A for chips when the cutting points were at full depth in the wood. A little clearance on the inside and end completed it, making what we machinists would call a hollow mill or box tool with two teeth.

Instead of getting the stock out in little cross-grained strips of wood as usual, it was sawed into long narrow strips like laths, wide enough for two rows of plugs. Putting the tool into the little high-speed upright drill, he adjusted the stop so that the cutter would not touch the table by $\frac{1}{64}$ of an inch.

With this tool it only took a boy ten or twelve minutes per 100 plugs to cut them out. Of course the cutter did not entirely remove them from the strip on account of the stop which kept it from cutting all the way through, which was done to prevent the

plug remaining in the tool. A plunger with a spring behind it to knock them out would have been an improvement, saving one operation. But it only took a few minutes to run the stock by the saw removing a thin strip from the back of the stock to complete the work.

Another order received within a few days called for 1 500 more of the same things, and they were made in the same way, saving in all about ten dollars worth of time.

Did the boss appreciate it? O, yes; he asked how much the tool cost, and paid the workman 20 cents for it. Workman's reward, four cents. "MILO."

A BORING CUTTER.

The other day I was shown a contrivance for boring, and it is being used considerably in the shops of Bement, Miles & Co., of Philadelphia. Thinking it would be of some benefit to your many readers, I submit this for their perusal and criticism.

First, I will make a sketch of it. Fig. 1 is the part I want to call your attention to more particularly. It is a piece of steel filed true, having the projections *a a'* and *b*. The distance *x* represents the diameter of the bar used. This piece will do for one sized bar only, but can be used for any sized cutter, The projection *b* (distance *y*) is a little less than distance *z* in Fig. 2;

Fig. 1

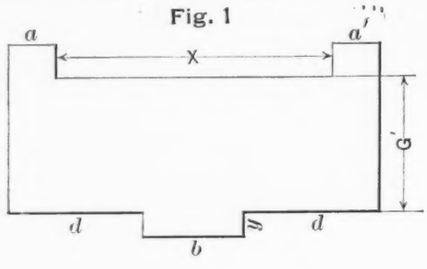
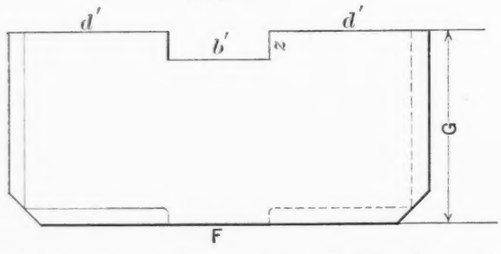


Fig. 2



this gives the top of the cutter *d' d'* a good bearing on *d d* and thus gets rid of that rocking motion that we often have with cutters. The projection *a a* keep Fig. 1 central with the bar, and as the width of *b* is the same as the width *b'*, it follows that the cutter must always come true without any hammering or coaxing. The slot in the bar must always be a little larger than the distances G + G', and may be held tightly by putting a small wedge under F. Now I think we can claim three advantages over the old style.

First. It takes less material, and that is no small matter when you have a great many cutters to make. (The distances G G' need not be over ½ inch each.)

Second, and I think the most advantageous. It keeps the cutter true and central with the bar, and this saves time.

Third. There is no rocking of the cutter, because you have a good solid bearing at *d' d'* and *d d*. But it must be remembered that Fig. 1 will only do for one bar, but as many cutters as you like. G. H.

HOT WEATHER PASTE.—INDUCTION COILS.

Hot weather is a bad time to keep paste. It gets sour and loses all its stick-to-tiveness. I have used for a number of years gum tragacanth, and it will stick a label to almost anything, and you do not have to hold it until the paste sets, for it sticks at once. The way I make it is to fill a wide mouth bottle (say about 2 oz.) about two-thirds full of the gum, then fill up with water in which a small lump of blue vitriol has been dissolved, which will preserve it. If the paste is too thick add a little more water.

No doubt some of the readers are interested in electrical matters, and are constructing induction coils, electric bells, etc. One item in the construction of apparatus is the expense of platinum for the contact points. A few years ago I got on to a cheap method of procuring platinum. Ask a friendly dentist for a few old "store teeth," and in each tooth you will find two pins of pure platinum which will answer the purpose admirably.

Can some of your many readers give me a design with working drawings for a simple and at the same time complete dividing attachment for the headstock of lathe to attach at tail end of mandrel? F. H. JACKSON.

MORE ABOUT GEARS.

The following letters to and from Mr. Webber will explain themselves and perhaps help out the gear question:

Mr. S. Webber:

In the September issue you figure out the horse power of a gear from a formula, HP. $= t^2 \times 5\,v$, and get it correctly to be 149.57. Now before you arrive at that formula you say that the breaking strain is T×F×8 000, or with a safety of 16 it is as you also state, T × F × 500, from which thus the

$$\text{HP.} = \frac{\text{T} \times \text{F} \times 500 \times 15.708 \text{ (vel. per sec.)}}{550}$$

which gives HP. = 128 only. CHAS. HANSEN.

The writer is in error in saying that I stated the breaking strain of cast iron as being T × F × 8 000, and the safe strain T × F × 500. I gave the strain as found for one *square* inch, and as the strength of a beam is always taken as being the *square* of its depth, multiplied by its width, if he had read $T^2 \times F \times 500$ he would have found the result as I gave it, assuming F to be = 5.5 T. For a 3 inch pitch T would be 1.38, and $T^2 = 1.904$ and

$$\frac{1.9044 \times 5.5 \times 500 \times 15.708 \times 149\ 57}{550} = 149.57$$

In my article, as printed, the width of face of gear, quoted from Mr. Cooper, is erroneously given as 6.5 inches. It should have been 7.5 inches, and if the calculation as carried out by the writer of that letter is made on that basis, the result will be 147.79 HP., about as stated by Jones and Laughlin formula.

Charlestown, N. H. SAMUEL WEBBER.

BELTS AND PULLEYS.

Your answer to question No. 8 in the October number, as to "the cause of belts running towards the center of crowning pulley" is so at variance with my own ideas, that I am led to make the following remarks.

Ever since I can remember, I have from time to time, heard the statement, "that a belt will run towards the high sides of a pulley," while as a matter of fact a belt never did run towards the high side of a pulley, except when running down, but it does have a persistent tendency to run towards the largest diameter.

This is not caused by centrifugal force as you hint is possible, for the slow moving belt has the same disposition as the fast moving one. In fact it is for certain reasons the more persistent of the two. If you or any of your readers are enough interested to make the following experiment, you will all have a different conception of the problem than you ever had before, unless you have seen the experiment tried, or some other of the same nature, and after you get the true conception you will be no more able to explain it to the next man than I am.

Take a small pulley say three or four inches in diameter, and as many inches wide or long, turned crowning as usual, tapering from the center each way, and with a long strip of paper an inch or an inch and a half wide, to represent a belt, start to wind the paper just one side of the center, in a direction that would wind it off of the end if continued, like a screw, and keep on winding it. You will find that before it has gone far, instead of its winding off, it is coming back up to the center, and so which ever side of the center it gets, it will come back if you keep on winding. I used to try and explain it by saying that the large diameter takes up the belt faster than the small, which draws the belt up to the middle, which, though all right as an explanation, is perfectly incomprehensible to the man who has not fathomed the underlying principle for himself, and winding paper around the pulley is the only way I have ever seen to picture the idea sufficiently vivid for human comprehension.

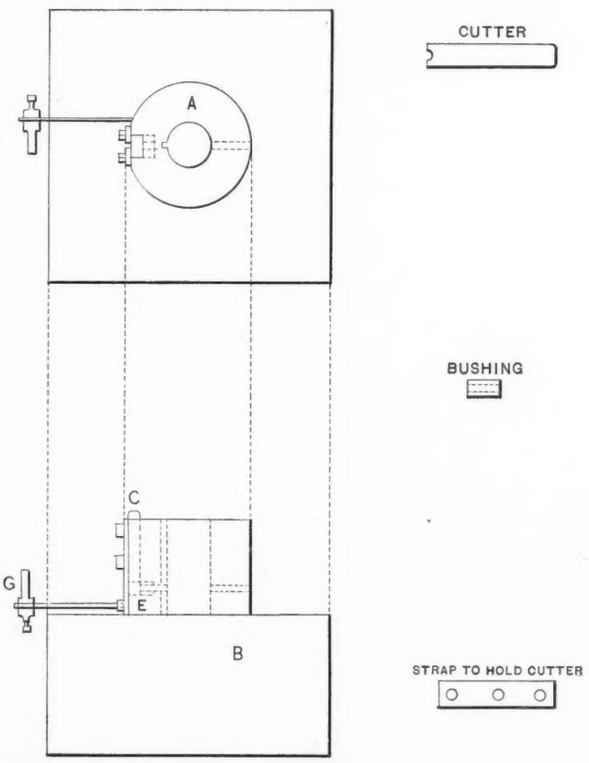
I wish to say a few words about the high side fallacy. I have seen mechanics raise one end of a countershaft to get the belt to run to the high side of a pulley, when the belt came on horizontally, which of course had no effect whatever. I have seen them do the same thing when the belt came from below, which made it all the worse, and I have seen them move one end of a counter

away from a line to get the belt to run in that direction, on the theory that that made it the high side, which was also dead wrong, and this all comes from using the phrase *high side* for *largest diameter*. If a belt was perfectly straight and of uniform thickness, it would have as good a right to run on the middle of parallel pulleys mounted on parallel shafts, as to run off; but belts are not straight or of uniform thickness, and though shafts may be mounted parallel, the pull of a belt is quite enough to spring them out, and the genius or duffer, who did what I can readily believe every one told him was wrong, made a pulley crowning instead of concave to keep the belt from running off; conferred a blessing on mechanics. He too is a unit in that army of the unknown benefactors of his kind.

Syracuse, N. Y. JOHN E. SWEET.

A ROD CUTTER.

I send with this a sketch of a device for cutting off rods, etc. The hub of a broken gear A was planed on one side to make a slot for the cutter C to slide in and to provide a surface to which straps or gibs might be bolted to hold the cutter in place. Hardened bushings for the various sizes of rods were made and fitted to a counter-bored hole E, which formed a guide for the rods to be cut. A gauge G was also provided. B is a wooden block on which the hub stands.



This device has been in use for several years, and is an expeditious way of cutting up small rods. The operation of cutting is by striking on cutter C with a hammer. Dimensions of hub, 13 inches diameter, 8 inches long, 5 inch hole.

I hope the above may be of use to some one of your readers, as I have never seen anything of the kind in any of the mechanical papers. ALLEN HAMMOND.

Rockville, Conn.

A NEW "OLD MAN."

The "old man" found in most shops differs very little from the first one made. The experience of the writer, like that of many other shop man, is that when the "old man" won't do, resort is had to planks, blocks, iron angles, etc., and in a great many cases just for the want of a movable joint between the foot and post. The enclosed sketch is an adjustable "old man," or drill stand. You will notice the male and female taper joint between the post A and foot or angle piece H, as shown by the dotted lines. With the taper of this joint, not too acute, and bolt I drawn up tight, the joint will hold for all legitimate work. Where the bolt I passes through the foot or angle piece H, it is made square at J; the hole K also being square, prevents the bolt turning and unscrewing from the nut. The sweep of the post A is a complete circle. 1 1 2 2 2 are bolt holes in foot piece. The arm B is of the same diameter as the post A. On the arm B is shown the piece C C, two views of which are shown. This piece C is of steel, and with the part marked by the small circles D, hardened. These small circles D are impressions to receive the point of the feed screw in the ratchet. This piece is used in place of putting center punch marks in the post and arm. It is movable and will fit either the post or arm, being held in

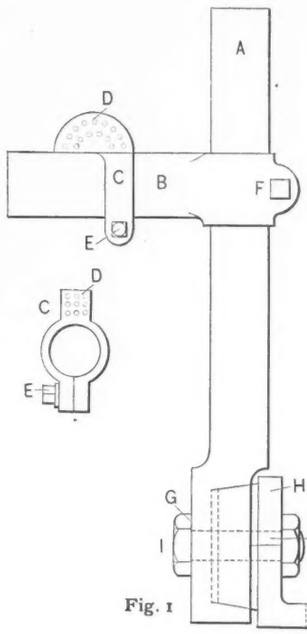
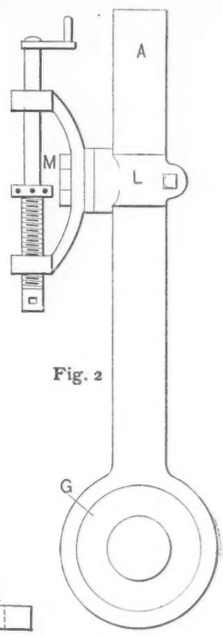


Fig. 1



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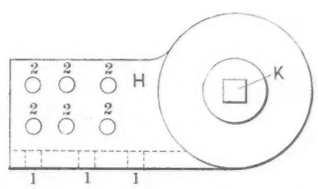


Fig. 3

place by the pinching screw E, and is made of such a shape as will come in line for all positions of the ratchet. In Fig. 2 is shown a hand-drilling attachment to be used for drilling small holes. It is pivoted on the piece L and held in place by the nut M. This attachment will fit either the post or arm, and will drill from ¼ inch down. The drawing is not made to scale or proportion. W. DE SANNO.

Indianapolis, Ind.

HOLLOW SHAFTING.

Some very interesting data concerning hollow shafting is given by Geo. D. Rice, in a recent issue of the *Iron Age*. The shafts experimented with were 2½ inches outside diameter, with holes varying from ⅝ of an inch to 1⅞ inches. They were tested by external pressure, and a strain as heavy as would be encountered in actual practice was continued for twenty-four hours upon the various shafts, to detect any crushing that would unfit them for constant use. The shaft having a bore of 1½ inch stood the test, while the one bored to 1¾ was indented so as to make it untrue.

The "wabbling" feature was also tested, and the hollow shaft proved superior to the solid in this respect.

The hollow shaft adapts itself to poor alignment of boxes, with less strain than the solid shaft, being more flexible, and there is less danger of breakage from this cause than with the solid shaft. Vibration was also less than with the solid shaft.

The main difficulty that occurs to the writer of the article is the mode of fastening pulleys to hollow shafts, and shallow keys, set screws and through screws, are considered in this connection. Fastening by clamping or compression is not discussed, but seems to be the solution of the question. The lesson we have learned in this line, by the extending use of wooden split pulleys, indicate that we can clamp a shaft tightly enough to twist it in two, and compression couplings and pulleys are desirable in every way. The saving in weight over solid shafting is greatly

in its favor, as this means a saving in power as well, and the loss due to transmitting power by long lines of shafting is not half realized or appreciated.

Camden, N. J. R. E. MARKS.

* * *

PRACTICAL MECHANICAL TOPICS.

Every new man going into a mill or taking charge of a plant thinks he must make changes somewhere, or he fears the treasurer, director and stockholder will think him no improvement on the last man. In some cases desirable changes are made, while in others very undesirable ones are introduced and a show kept up until it can be endured no longer, and then another new man is called to take the management. A practical man will make no changes unless he knows he is right.

I went to an establishment very lately where I found that some changes for the better could be made. In the boiler department I found a spray pipe just below the water-line in the boiler, as marked B in Fig. 1. I took out the pipe and found it so clogged with dirt that you could not insert the point of a fine needle into it. Wouldn't it be better to have the pipe in high enough to be out of the water altogether, may be asked? No, for then the spray would dampen the steam, acting as a jet condenser; the best way to put one in is to have it about half way between the top row of tubes, A, and the water-line. But the pipe should be

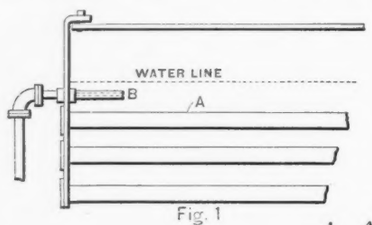
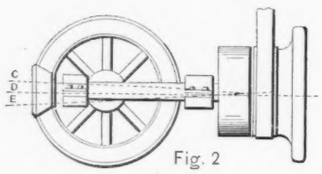


Fig. 1



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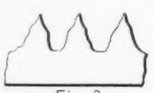
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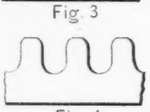


Fig. 4

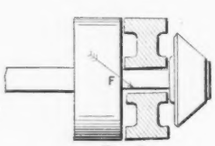
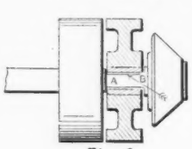


Fig. 5



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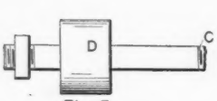

Fig. 7

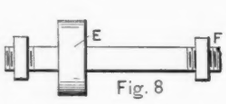

Fig. 8

at least eight feet long and well perforated with small holes, then it would be far less liable to stop up. By doing so in this case the work of the boiler was improved. Use brass composition pipes for this purpose. It takes just as long to lay iron as brass, and the latter once laid will out-last several pieces of iron.

Imperfect adjustment, or running gears too far out of mesh, and many a time neglect in oiling, will all tend to cause such wear as is show in Figs. 3 and 4. Fig. 4 shows a segment of a perfect gear. Fig. 3 shows worn teeth. Suppose the system of gearing is run according to the plan shown in Fig. 2. The proper setting demands that the center of the pulley and shaft be in line with the gear as per the dotted line D. If the adjustment is as per either line, C or D, the meshing of the cogs will be irregular and wearing will result, as shown in Fig. 3. If the gear is worn that way, it is almost impossible to get a good movement, because the friction and the consequent springing of the gears will impart a decided jar to the machine; will check its steady running and will cause a sort of weakening or failure of power. Now just think for a moment what a tremendous pushing against each other these gears will perform when an extra strain is put upon them. Any mechanic has noticed that if a chisel is used to do the work of a screw-driver, it prys itself out of the notch, cam-like, when you turn it; it has no side to it to flatten against the sides of the notch of the screw. It is the same with these teeth. They really operate like two cams, one pushing against each other. Go and get a new set of gearing when any is found worn like this.

Now, in order to have all these things I have mentioned carried out (and they have got to be faithfully carried out in order to make your business successful) a great deal of course, will depend on overseers, but no matter how good and competent men they may be, or how conscientious they may be, there is still a greater duty devolving on the superintendent or owner (if he does his own superintending); he must be on the alert all the time, for he must see that the overseers and millwrights do their duty in a faithful manner, he can also see many things that can be improved in if he is looking around the mill often.

HINTS ON KEEPING UP THINGS.

He will also be obliged to make comparisons as to what are the best methods of doing certain things, he can also soon find out what kind of stock runs best in the machinery, also what kind of stock makes the best waste.

A man in a superintendent's position can see many ways to save a good deal of money if he is studying to save money, and it is this kind of saving that helps to make the business successful.

A good deal of second-hand machinery is flying about the country from time to time. Some manufacturers wish to make extensions and improvements, but feel that they cannot afford to buy new machinery and so invest in some cast-off machinery, got cheap from a broken-up or broken-down mill. The opinion expressed by an old manufacfurer is that nine-tenths of this second-hand machinery should be smashed up and sold for old metal—at least such is the character given to the old machinery that is to be gathered in some places.

Antiquated machinery is a poor investment at any price, but some of it can be fixed up to run fairly well. Suppose a pulley bearing is worn as shown at F, in Fig. 5. This may be fixed by turning down the shaft, A, even, and inserting a shell in the pulley hub, as shown at B, in Fig. 6. Suppose studs are broken off at C, as shown in Fig. 7. The stud can be made over by turning down the shoulder D to the size shown at E, in Fig. 8. This will gain space, and a new thread and nut may be put on at F.

SPEED OF MACHINERY.

The speed of machinery is a very essential consideration as to efficiency, and is contingent on many circumstances. Many persons who wish to increase the speed commence by decreasing the diameter of the driven wheel on the machine: this is wrong in nearly every case, and for the following reasons:

By decreasing the diameter the belt surface is diminished, requiring a tighter belt, and increasing the friction more than double of what the increase of speed would cause.

By experiments made at Metz, under the sanction of the French Government, to determine as nearly as possible the laws of friction, it was fully established that the friction of motion is wholly independent of the velocity of motion.

The proper place (under most circumstances) to alter speed would be the driving wheel; as not only is the belt surface diminished by altering the driven wheel, but the belt has to make a shorter bend, wearing out its life and breaking out the belt hooks, by the smaller curve, thus adding to the expense of running the machine.

TESTS OF OILS.

A great improvement has been made in the quality of oils within the last decade, and special attention given to this important feature would result in obtaining still better results. I advocate the plan of having an oil test room in order to see what oils are the best and most economical to use, also that every mill and shop should have a clause inserted in their yearly contracts that every shipment of oil should be guaranteed to run a certain horsepower, as indicated by a power scale placed on frames in the test room. M. W. DANIELSEN.

POSITIVE LUBRICATOR.

On the continent of Europe there is very considerable use made of pump lubricators and press lubricators which insure positive feed and supply of oil, or grease, or graphite compound, as the case may be, to one or more machines. These are especially desirable where that admirable lubricant graphite, is used in combination with either oil or grease, as graphite has a tendency

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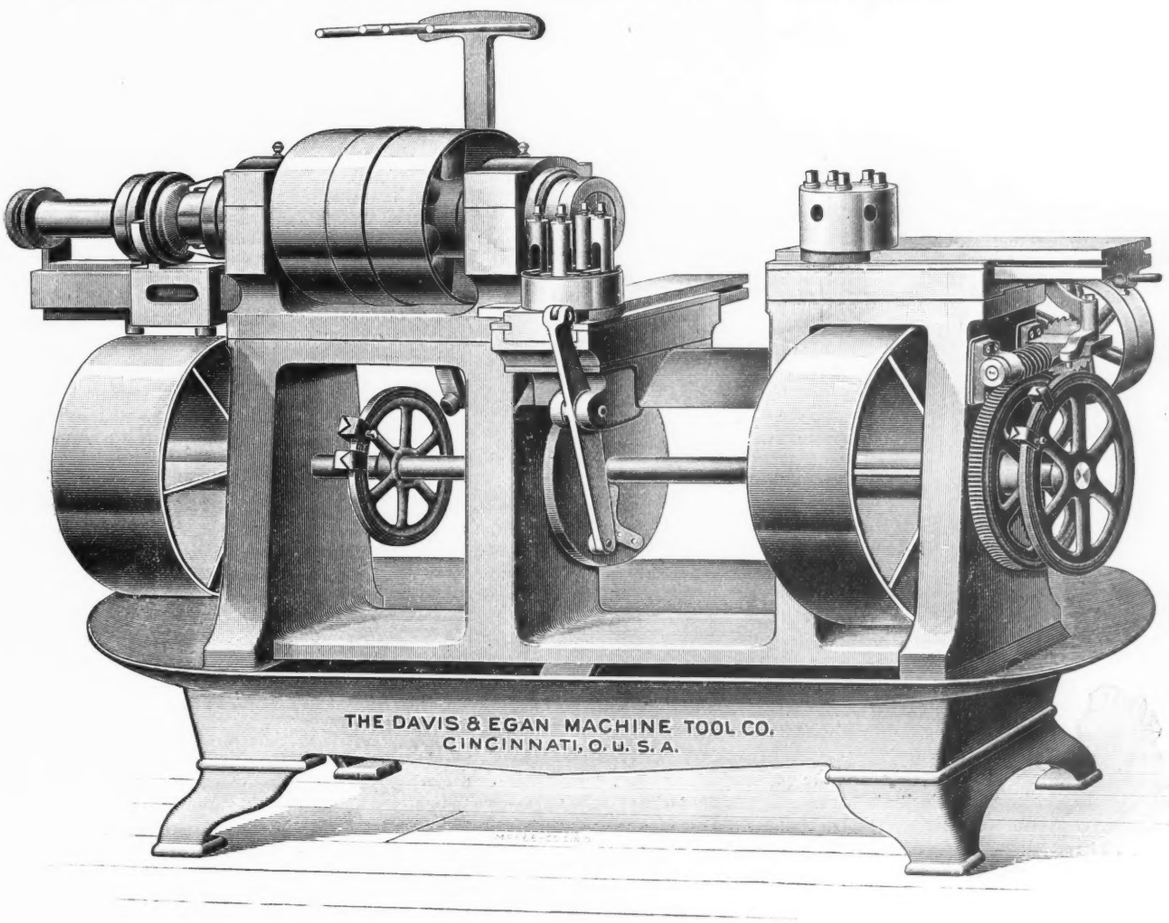

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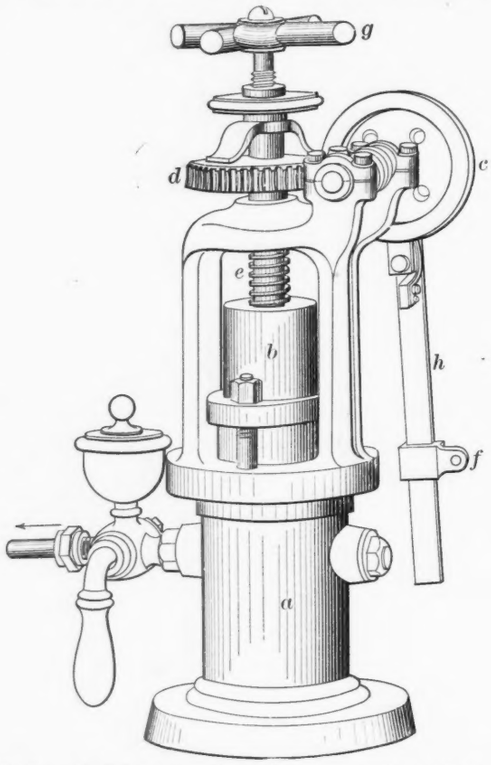
to clog the pipes which should convey it to where it is needed.

In the device shown in the accompanying engraving, the grease or other lubricant is contained in a stout reservoir, *a*, which has a stuffing-box in which plays very tightly (not necessarily stiffly) a plunger, *b*. This latter is forced gradually down into the reservoir, *a*, by the screw, *e*, which receives intermittent rotation from the worm-wheel, *d*, which itself is moved by a worm on the shaft of the wheel-plate, *c*. This latter has on the side not shown a ratchet, worked by a pawl on the lever, *h*, which has an adjustable attachment, *f*, in connection with some reciprocating part of the engine or other machine, or having a pitman connection with some rotating part. Thus at each reciprocation or rotation of the machine, a fixed but "regulatable" quantity of lubricant is forced to where it is wanted on the driving machine or elsewhere. The position regulates, in great measure, the quantity of lubricant forced. Stoppages are practically impossible. The oil outlet is at the upper part of the reservoir to lessen the possibility of solid impurities getting in the outlet-pipe and to facilitate filling. The star wheel *g* (the spindle of which has a lock-nut) enables adjustment of the plunger *b*.



Dresden, Germany. ROBERT GRIMSHAW.

* * *

ADVANCE IN FREIGHT RATES.

NEW ENGLAND machinery manufacturers enjoy a decided advantage over those in the Middle and Western States, as they have been able to ship their product from Boston and Liverpool until recently at four shillings ($1.00) a ton by the Warren Line. Lately, however, the Wilson, Warren and Furness lines have been consolidated, and freights were lately advanced to eight shillings a ton; but even this is less than one-third the present rate from New York to Liverpool. The large increase in grain and other shipments during the last few months has caused ocean freights to advance with great rapidity.

* * *

EVENING CLASSES IN STEAM ENGINEERING.

THE STEAM ENGINEERING CLASS of the Young Men's Institute, 222-224 Bowery, this city, opened its 1896-97 session on the evening of October 7, 1896, and will continue open Wednesday and Friday evenings of each week until April 29, 1897. The class is in charge of Mr. Wm. H. Weightman, as usual. Its object is the instruction of all employed or expecting to be employed in the practical operation of engines, boilers and machinery, and desirous of gaining a knowledge of or improving themselves in the theoretical branches, rules and practice of steam engine, boiler and power transmission calculations. Those desiring to avail themselves of the opportunity should join at once.

MANUFACTURERS' NOTES.

THE DAVIS & EGAN CO. write: "We are pleased to report a general improvement in trade during the past ten days. We have received quite a number of good orders from various parts of the United States and our foreign business continues active. Inquiries are plentiful and we anticipate a brisk trade immediately after the election."

RECENTLY, in an interview with Mr. Thos. P. Egan, president of the great wood-working machinery manufacturers, The Egan Co., Cincinnati, O., he said:

"I don't like to talk politics to business people, but I firmly believe that the free coinage of silver would put me at a disadvantage in the markets of the world. I am after the foreign trade, and am getting it, too; but don't send me out with a (silver) spear to fight England with a (gold) needle gun—it gives me no show.

"I want the Egan Company to sell wood-working machinery not only to all parts of the United States, but also to every country on the globe, and keep our American skilled mechanics employed full time and at full wages, payable in gold."

WE mentioned sometime ago that the Bickford Drill & Tool Co., Cincinnati, Ohio, were putting up a new building and now are advised of its completion. The building contains 25,000 square feet of floor space and is erected on the old site at the corner of Front & Pike streets. The construction is of the modern type so as to give the greatest amount of light possible. On the first floor are the heavy tools such as planers, lathes, boring mills and radial drills, and also the erecting floor, which is fitted with three traveling cranes. The second floor contains the office, tool room, lighter lathes, gear cutters milling machines, together with the lockers for the men. On the third floor is the drawing room, stock room, and vice benches for manufacturing the smaller parts of the machine in quantities. The shop is modern in every way, and inspection is invited.

* * *

FRESH FROM THE PRESS.

Block and Interlocking Signals. W. H. Elliot, Signal Engineer, C., M. & St. P. R. R. Locomotive Engineering, New York. 277 pages, 6 x 9 inches. Price, $3.00.

This contains a series of articles which appeared in *Locomotive Engineering* and which attracted widespread attention. It is written by a well known authority on signaling and fills a place in railroad literature which has hitherto been an aching void. It describes in detail the various systems and the most approved methods of signaling, and is profusely illustrated with both detail drawings and photographic reproductions of the systems in actual use. It is handsomely gotten up, has excellent paper and printing and is bound in flexible leather covers, which makes it very convenient to handle. We trust it will be appreciated as it deserves.

Roentgen Rays and Phenomena of the Anode and Cathode Edward P. Thompson, M. E. D. Van Nostrand, New York. 190 pages. $1.50.

This seems to be a very complete work, with the experiments of Faraday and others, in the early days of electrical research, all given in a concise and available form, being well arranged and easily found. It treats the subject very carefully and in a thorough manner, showing the apparatus, its use and the results, in a way that will interest any of our readers from the apprentice to the manager in the discovery which has become so widely used in such a short time. The illustrations and typography are both good. There is a good portrait of Dr. Roentgen, who has approved the book. The concluding chapter is written by Prof. Wm. A. Anthony who is well known in electrical circles.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

J. A. FAY & CO., Cincinnati, Ohio. Catalog of Wood Workers. 32 pages, 8 x 10½ inches.

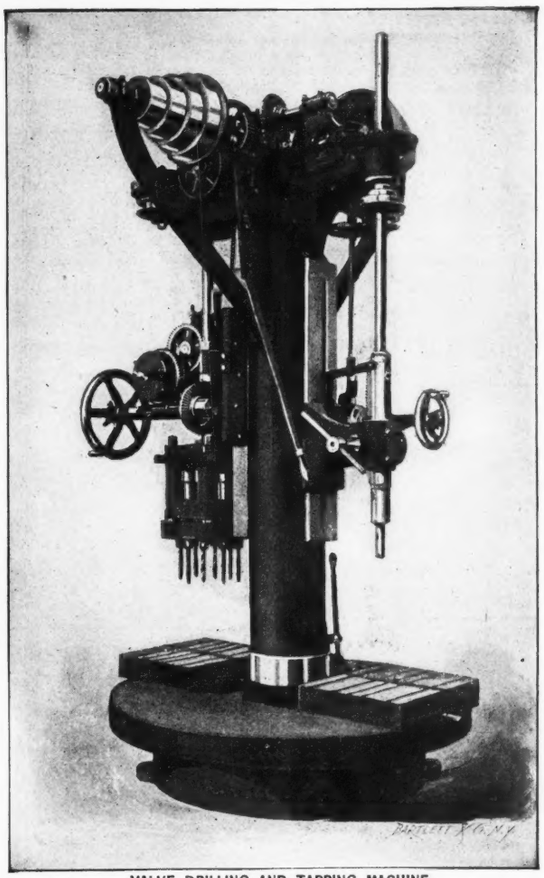
Under the title of "Woodworkers, Variety and Universal," there is given considerable information in this line, which, together with the illustrations, gives one a good idea of these tools. This is sent free to applicants.

INSTITUTE FOR HOME STUDY OF ENGINEERING, Cleveland, Ohio. Description of methods and appliances.

This is a very complete pamphlet, and gives anyone who is interested in mechanics or electricity a good idea of the easiest method for taking up its study, by correspondence. The use of apparatus, especially in the electrical courses, is highly commendable.

H. N. BATES MACHINE CO., Boston and New York. Catalog of Machinery for Transmission of Power. 160 pages, 6x8 inches.

This is a catalog which will interest engineers and mechanics who deal in power transmissions, by line shafting, clutches, etc. It shows a large variety of such appliances as pulleys, hangers, clutches, couplings, shafting, pillow blocks, roller bearings and gearing. They also



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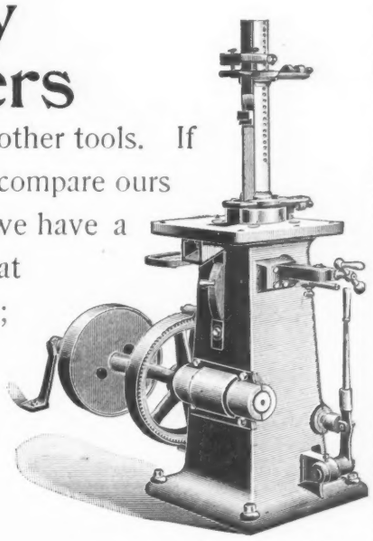

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BAKER BROTHERS, 355 South Erie Street, Toledo, Ohio. Catalog of Key-way Cutters. 40 pages, 6 x 9 inches.

This shows, by excellent illustrations and well written text, the good points of the Colburn Key-way Cutter, which, judging by the many favorable testimonials, is a very efficient tool for this kind of work. The details give a good idea of the operation of the machine, show its special features and should do much to aid the sale of these machines. The attachments shown enable it to make keys or cut racks, in addition to regular key-way work. The catalog also contains considerable information on keys and their dimensions which will be appreciated by machinists and others.

WALWORTH MFG. CO., Boston, Mass. Table of Dimensions of Valves and Fittings. 32 pages, 10 x 15 inches.

A very handy book of reference for engineers in laying out piping plans of any kind, as it includes about all the valves and fittings liable to be called for. This company is making a specialty of wrought iron pipe bends with flanges, all ready to put in place. The least practicable radius for these is said to be five diameters, with larger radius recommended.

WESTINGHOUSE MACHINE CO., Pittsburgh, Pa. Catalog of Engines. 6x9 inches.

This is a plain, business-like catalog, showing the new plant of this company and their engines installed in various plants throughout the country. It describes the engines and their performances in a concise manner and will be of interest to engineers generally.

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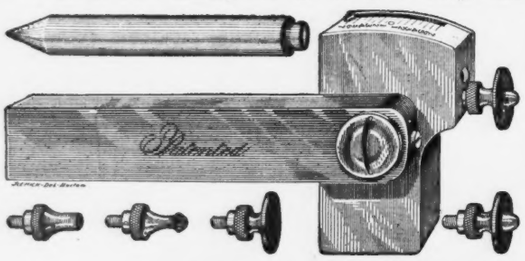

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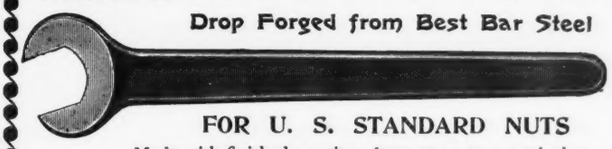

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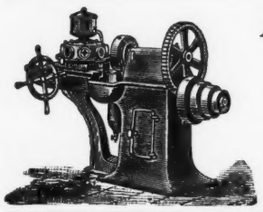

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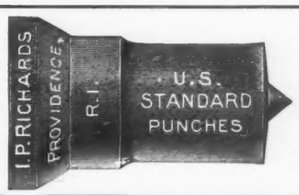

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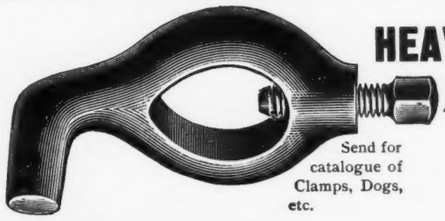

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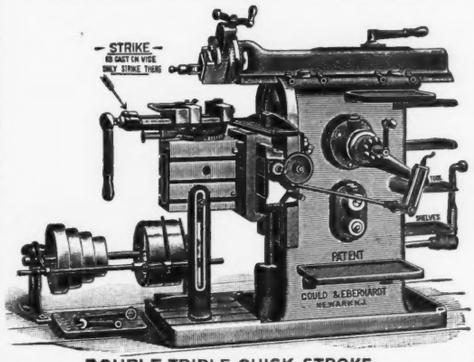

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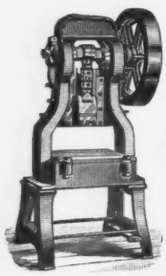

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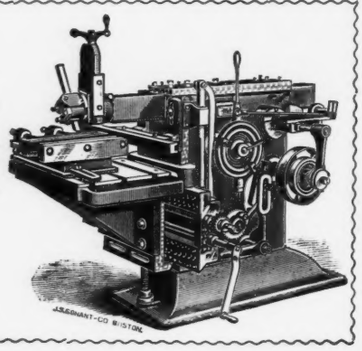

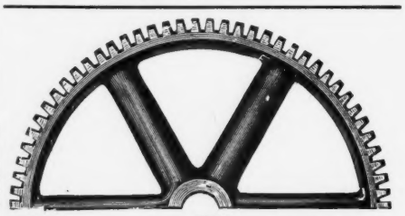

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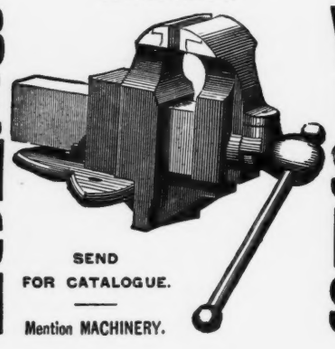

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